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The State and Medical Research

IN the Harveian Oration, delivered by Sir Edward Mellanby before the Royal College of Physicians on October 18, and summarized in NATURE of October 29, certain points were raised of such importance, particularly at the present time, that it seems desirable to underline and amplify them.

A realization of the urgent need for medical research makes no call on the imagination, and demands no special medical knowledge. We have all seen pain, disease and death at close enough quarters to wish that we were better armed against them; and it is evident that the only effective arms we can hope for are those fashioned for us by science.

What is not so fully realized, at least by the general public, is that the case for extended research is stronger than ever before, because the prospects are brighter. As always in the growth of science, each new discovery brings other discoveries a little nearer, so that the potential rate of advance continuously increases. It would not have been easy, fifty years ago, to indicate how large sums of money could best be spent to hasten our acquirement of the knowledge that alone will enable us to control disease. It is certainly true to-day that our rate of advance is mainly determined by finance. We can spend, to advantage, more than there is any likelihood of our obtaining; and the date at which mankind will be freed from the dread of such killing or disabling diseases as cancer, tuberculosis and rheumatism depends, in the main, on how much we are prepared to pay. This does not mean that a frontal attack is necessarily the best or the speediest method of gaining the knowledge that we require. The sure road to success is to stimulate the growth and development of the medical sciences as a whole. Lister followed Pasteur; aseptic surgery was the outcome of studies on fermentation. We cannot tell where we shall find the key to any of the more obstinate puzzle-locks of medicine.

It is only by adequate and wise endowment that such a growth of the medical sciences can be secured. The return such endowment would give us may reasonably be assessed in the light of our gains in the past. To take only recent advances, diabetes and pernicious anæmia, incurable and fatal diseases not many years ago, are now readily controllable. We can, if we choose, eliminate diphtheria as an important infection of childhood. We are at last in sight of an effective attack on influenza, one of the major killing diseases of adult life. The discovery of the therapeutic action of sulphanilamide, and its related compounds, has not only given us our first effective weapon against puerperal septicæmia, the main cause of maternal mortality, but also has brought bacterial infections in general into the field of chemotherapy, which hitherto seemed to be limited to protozoal diseases.

The funds required to maintain a healthy activity throughout the whole research field involved, and to concentrate additional resources at any point which promises a rapid advance, are large—large at least in terms of the inadequate resources that have been available in the past, though trivial in comparison with the sums expended on health administration that is often ineffective because it lacks the necessary knowledge on which to act. Some part of the money required may be provided by the munificence of private donors, or by public subscription. Sir Edward

Mellanby instanced some of the funds available for this purpose, such as those administered by the Leverhulme Trustees, the Halley Stewart Trustees, and the British Empire Cancer Campaign. There is an expectation of additional support from the Wellcome Trustees; and British medical research already owes much to the generosity of the Rockefeller Foundation of America—a generosity which, as Sir Edward emphasized, might well prick the conscience of some of our own countrymen. It is reasonable to expect more help from industry in the future than we have received in the past, particularly in the rapidly expanding field of chemotherapy; and it is perhaps not too much to hope that our large life insurance companies, which benefit directly from the increased expectation of life consequent on the increase of medical knowledge, may one day be stimulated by the admirable example set by similar bodies in the United States. But, whatever help is available from such sources as these, it is inevitable that the greater part of the burden should be carried by the State, for the State bears the ultimate responsibility for national health and for financing the measures that are necessary to secure it. It is in relation to the form in which State endowment can best be supplied and utilized that Sir Edward Mellanby's account of the working of the Medical Research Council is of particular interest.

Bureaucracy, giving the term its common and well-justified implication, is the inveterate enemy of research. State endowment means State control; and if 'State' and 'bureaucratic' were synonymous terms the outlook would be dark. But the Medical Research Council, under the wise guidance of its two secretaries, the late Sir Walter Fletcher and now Sir Edward Mellanby, has shown that bureaucracy is a malignant growth that a Government department can quite easily prevent by a simple willingness to delegate, not final authority, but provisional decisions, and the carrying out of plans that have been approved. Incidentally, the Council has also shown that bureaucracy is as expensive as it is obstructive, and that its elimination leads to a great saving of public funds. Working through a large number of unpaid expert committees, the Council has encouraged those who know how research can best be stimulated and assessed to do these things for nothing. As a result, the Council's administrative expenses are a very small fraction of the total funds at its disposal, and the greater part of its financial resources are expended on the salaries of research workers, or on the laboratory expenses associated with their work.

Moreover, by enlisting the voluntary help of a large number of senior workers in universities, research institutes and hospitals, the Council has been able to co-ordinate investigations in a way which no other body could approach, and to ensure, so far as is humanly possible, that economy is safe-guarded by terminating lines of research that have served their purpose, or have failed to fulfil their promise, and by concentrating the available resources in the most promising fields. Its ability to do this, it should be noted, is largely due to the fact that it acts on the advice of those who know what is actually happening, and, as a result, has won their trust and willing co-operation. It does not seem impossible that a method which has proved so successful in one branch of Government activity might be equally effective in others. We are an empirical people, and learn more readily from experience than from argument.

One other point that was stressed by Sir Edward Mellanby deserves further amplification—the unnecessary lag that is apt to occur between the discovery of a method that is applicable to the diagnosis, cure or prevention of human disease and its adequate practical exploitation. This lag is far less conspicuous on the curative than on the preventive side. A new therapeutic agent tends to be tried out at once, and on a wide scale. The trouble is that the trial is often uncritical and uncontrolled, and that the factors that determine the use, or abuse, of the new remedy take longer than they need to win general recognition. The Medical Research Council has made a start towards removing this defect by setting up a Therapeutic Trials Committee.

It is on the preventive side, and particularly in relation to the application of new methods of preventing infective disease, that the lag is longest, and the position in Great Britain is most discreditable, perhaps because this field of activity, on its applied side, has not hitherto been regarded as falling within the Council's sphere. It is not flattering to our sense, humanity or self-respect that we have no central or regional institutes of hygiene, or State laboratories, comparable to those that have been established in the great majority of other civilized countries. The United States, in addition to the National Institute of Health at Washington, has numerous State institutes such as the Division of Laboratories and Research of the New York State Department of Health. Germany

has the Reichsgesundheitsamte in Berlin; Denmark, the State Serum Institute in Copenhagen; Italy, the Institute of Public Health in Rome; Poland, the Institute of Hygiene at Warsaw; Hungary, the Institute of Hygiene at Budapest; Turkey, at Ankara; Czechoslovakia, at Prague; Rumania, at Bucharest, Jassy and Cluz; Yugoslavia, at Belgrade and Zagreb; and so on.

All these institutes, though varying in their detailed functions, and in their exact relation to the State, serve as national or provincial centres which stimulate the scientific attack on infective disease, aid in the practical application of new discoveries to preventive problems, and provide, for public health administrators, facilities that they could obtain in no other way.

Other parts of the British Commonwealth are, in this matter, well ahead of Great Britain, as is shown, for example, by the admirable work carried out by the Connaught Laboratories in Toronto. Our neglect of this obvious deficiency is humiliating, and not without its dangers to health even in ordinary times. In times of emergency it may, unless remedied, entail improvisations that, with all their attendant difficulties and disadvantages, would be unnecessary if our peace-time organization were less defective.

In many ways the practice of medicine in Great Britain is as good as anywhere in the world. British public health legislation and practice have a proud history since the days of Chadwick and Simon. Our universities and our institutes of medical research have made outstanding contributions to knowledge, and are fully capable of adding to them. Our future position in the world of medical science which, in addition to its national importance, plays no small part in international relationships and co-operation, will depend mainly on the willingness of the Government to provide the necessary funds, and on the extension to wider fields of the wise methods by which the Medical Research Council has encouraged integration, while allowing freedom and initiative, within the territory it has covered in the past. In particular, there must be a clearer recognition of the interdependence of research and practice. A problem in the prevention or cure of disease has not been solved until a finding reached in the laboratory has been tested and applied in the ward, or in the field, and has been exploited to the limits of its usefulness. The method of approach that will succeed in the earlier stages will succeed in the later, and other methods will fail. The bureaucratic method is as incapable of applying discoveries effectively as it is of making them. State endowment and encouragement of those who alone can do the work required will yield the results we need, and yield them at the minimum cost.

Modern Methods in School Science

A Modern Introduction to Science

By Dr. W. P. D. Wightman and A. O. Chesters. Part 1. Pp. vii + 158 + 4 plates. 2*s*. 3*d*. Part 2. Pp. vii + 170 + 4 plates. 2*s*. 6*d*. Part 3. Pp. vii + 248 + 4 plates. 3*s*. 6*d*. Part 4. Pp. viii + 275 + 6 plates. 3*s*. 9*d*. (Edinburgh and London: Oliver and Boyd, 1936–1938.)

THERE is something arresting in the title which Dr. Wightman and Mr. Chesters, of the Edinburgh Academy, have given to this series of books. "An Introduction to Modern Science" might mean many things, but "A Modern Introduction to Science" suggests that the authors have a new method of approach; and so, in fact, they have. They have shared the dissatisfaction of many teachers with the traditional ways of teaching elementary science, and their main aim is to guide a young reader towards "reasoned answers to questions to which his own curiosity naturally leads him". Accordingly, each topic is presented as a problem to be attacked in a spirit of discovery and "not as a verification of something already known". In elucidating problems, the authors often follow historical lines and usually they have done so with admirable discretion. In general, it may be said that they present science as a matter of personal concern to the young students, who are enabled to pluck the fruits of knowledge from all the main branches of the subject.

The first two parts of the series were already printed before the Science Masters' Association made its interim report (1936) on "The Teaching of General Science". In their preface to the last two parts of their work, the authors comment upon the close agreement between the findings in the report and "the principles which they had quite independently come to regard as basic". The similarity is indeed quite remarkable; for the

work reads almost as if it had been written with the report as its basis.

The agreement is even closer than the authors themselves realize, for their method of presentation, which they call the "unitary approach", is in complete accord with the findings in the report. The authors are mistaken in thinking—to quote from their preface—that "the Committee were of the opinion that the tripartite division of science was so natural and convenient that to depart from it savoured of artificiality". What the Committee said on this point—and it was stated in italics—was that 'general science' should seek "to elucidate the general principles observable in nature without emphasising the traditional division into specialised subjects until such time as this is warranted by the increasing complexity of the field of investigation, by the developing unity of the separate parts of that field, and by the intellectual progress of the pupils". That, again, seems to be exactly as the authors think desirable; for, as they state in their preface, they cast Part IV of their book in sections corresponding roughly to the principal branches of science. The agreement in principles between the authors and the Committee seems to be complete; and, as might therefore be expected, there is close similarity in the choice of teaching material as well as in the method of presenting it.

One can imagine a classically trained sixth form boy, who wished to know what science was about, simply revelling in this work; but there are a few points which cause misgivings about its application to the small boys for whom the earlier parts of the book are designed. The style of the English in the first part of the book, since it is no simpler than that in the last, seems too hard for the younger boys. The chemical balance is introduced too soon. The general treatment is too logical for the beginners, who are at an age when they hunger for facts and experience and soon tire of trying to follow a long train of reasoning. It might have been wiser to sacrifice some of the logical connexions in order to crowd the first part with things which are easily comprehended by young minds. In Part II, which one may suppose will be studied by boys of thirteen or fourteen years of age, the historical method of approach to electrical ideas seems to be laboured, and one wonders (page 121) how many boys will "remember the shapes of graphs of the type $y=x^3$". These, however, are debatable points, which have been mentioned didactically for the sake of brevity. They should not be allowed to detract from a favourable opinion of a series which marks a notable advance in methods of teaching science to beginners.

C. L. Bryant.

The Theory of Allotropy

Die Theorie der Komplexität und der Allotropie
Von Prof. Dr. A. Smits. Pp. xii+372+5 plates. (Berlin: Verlag Chemie, 1938.) 19.50 gold marks.

THE views held by Prof. Smits as to the complexity of phases which are usually considered to be simple were set out in his "Theory of Allotropy" published in 1922. Since then many new results have been obtained, and the present volume lays special emphasis on the new experimental data and their interpretation from the point of view of the theory.

The book opens with a chapter describing the experimental evidence for "pseudo-components" from vapour pressure and melting point anomalies. The fundamental hypothesis is then defined: ". . . all phases, including the gaseous and solid phases of a so-called simple substance are composed of different kinds of molecules which are interconvertible". The remainder of the volume consists of a full theoretical discussion of the consequences of this hypothesis when the rate of interconversion is slow, together with a detailed description of experimental studies of systems in which the rate of interconversion is slowed down by intensive drying or by low temperatures.

One of the most interesting points which arises from the theory concerns the physical or chemical nature of the different kinds of molecules which form the pseudo-components. A brief discussion in one chapter suggests that, apart from chemical isomerism in more complex molecules, one may have to consider differences of nuclear spin as with ortho and para hydrogen, or rotational energy differences as in crystals of ammonium chloride. In the limit, it may even be necessary in a gaseous phase to regard each group of molecules with a given rotational energy quantum as a pseudo-component! For systems of the type of SO_3 and intensively dried benzene, the data are interpreted as indicating interconversion between polymers and simpler molecules.

Both theory and experiment are described with admirable clarity and the book is enriched by a large number of well-chosen diagrams. S. S.

Modern Organic Chemistry

Organic Chemistry: an Advanced Treatise. Editorial Board: Henry Gilman, Roger Adams, Homer Adkins, Hans T. Clarke, Carl S. Marvel, Frank C. Whitmore. Contributors (other than Members of the Board): C. F. H. Allen, W. E. Bachmann, A. H. Blatt, M. T. Bogert, W. R. Brode, L. F. Fieser, R. C. Fuson, E. Heuser, C. D. Hurd, J. R. Johnson, T. B. Johnson, J. A. Leermakers, P. A. Levene, K. P. Link, L. Pauling, A. L. Raymond, A. Rothen, R. L. Shriner, L. Small, W. H. Strain, E. S. Wallis, M. L. Wolfrom. Vol. 1. Pp. lvi+857. Vol. 2. Pp. lvi+858–1890. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1938.) 37*s*. 6*d*. net each volume.

THE very rapid growth of organic chemistry, alike on the descriptive side and in the theoretical aspects of the subject, has produced acute problems for teachers of chemistry, particularly for those concerned with final honours or post-graduate students. Whilst numerous and excellent elementary and intermediate text-books are available for use in the early stages of the curriculum, comprehensive advanced treatises are few in number.

The volumes under notice, planned by an editorial board of American chemists and written by American chemists, go far towards filling the gap, and their publication is to be regarded as an outstanding event in the bibliography of organic chemistry. The variety and extent of the subjects to be considered render it inevitable that a treatise of this type must be a joint effort, and the two volumes under review consist in effect of a series of monographs written by acknowledged authorities on these special subjects. The names of the members of the editorial board and of the contributors, given above, are sufficient indication of the high quality of achievement to be expected in the various chapters, and their success in providing readable, authoritative, and well-balanced accounts of the various subjects is amply confirmed by a study of the work. Each of the chapters is a fully documented monograph, complete in itself but carefully related to the general scheme of the work, giving a review of the subject as it stands at the present day, with many references to new work published so recently as 1937. It is a welcome feature that by adopting the method of separate sections, the editorial board looks forward to flexibility in bringing new editions up to date and including in them chapters on subjects omitted from the present volumes.

In a short review, no attempt can be made to refer in detail to each of the twenty-two separate monographs, but some idea of the wealth of subject-matter may be derived from a brief consideration of the subjects selected for discussion. A masterly survey of the theory of the structure and reactions of aromatic compounds by L. F. Fieser occupies some 100 pages, whilst the related subjects of modern electronic concepts of valency and the significance of resonance to the nature of the chemical bonds are dealt with in important chapters by J. R. Johnson and L. Pauling respectively. Carbohydrates are included in three sections, the first by M. L. Wolfrom, who deals with the general problems of stereochemistry, ring structure, etc., and the chemistry of the simple sugars and oligosaccharides. A. L. Raymond writes on substituted and derived sugars, including vitamin C, and on the isomerization and degradation of sugars, including fermentation. In the third section, E. Heuser provides a comprehensive account of the chemistry of cellulose. The long article (256 pages) on stereoisomerism by R. L. Shriner, Roger Adams and C. S. Marvel amounts practically to a complete and much needed text-book on this branch of organic chemistry, and there are further chapters by P. A. Levene and A. Rothen on optical rotatory dispersion, one of the newer and potentially very valuable methods of investigating organic substances, and on the theory of strain by R. C. Fuson. Amongst the groups of natural products included are amino-acids (H. T. Clarke), pyrimidines, etc. (Treat B. Johnson), alkaloids (L. Small), anthocyanins and flavones (K. P. Link), carotenoids (M. T. Bogert) and sterols, bile acids and related compounds (W. H. Strain). There are sections on organometallic compounds (H. Gilman), free radicals (W. E. Bachmann), unsaturation and conjugation (C. F. H. Allen and A. H. Blatt), open chain nitrogen compounds (C. D. Hurd) and other aspects of organic chemistry are considered in sections on molecular rearrangements (E. S. Wallis), comparison of chemical reactivity (H. Adkins) and on constitution and physical properties (W. R. Brode and J. A. Leermakers).

When so much is given, and given in a manner which it is difficult to praise too highly, it would appear invidious to wish for more. It seems unfortunate, nevertheless, that the really excellent

sections on the carbohydrates, which include cellulose, should contain no account of starch, glycogen, hemicelluloses, polyuronides, or other related polysaccharides. Furthermore, the account of the nucleic acids is scarcely adequate in its references to modern work. It is inevitable, however, that a work of this kind should be incomplete as regards subjects selected for discussion, and in the preface the editor-in-chief promises additional chapters on polymerization and on chlorophyll for inclusion in the next edition. When it is found that the present edition runs to nearly 2,000 pages, some idea is gained of the scope of modern organic chemistry. The work is well produced, and the clear type and the excellence of the numerous formulæ and diagrams deserve special mention. These are quite certainly volumes the merits and importance of which render them indispensable to all serious students of organic chemistry.

E. L. H.

Research near the Absolute Zero

Low Temperature Physics

By M. and B. Ruhemann. Pp. ix + 313. (Cambridge: At the University Press, 1937.) 18*s*. net.

APART from the determination of the characteristics of the liquefied gases used to produce low temperatures, the original aim of low temperature research was to investigate the fundamental properties of matter in the absence of the disturbing effects produced by thermal agitation. Although this aim has been to a large extent achieved, its attainment has been complicated and research made more exciting by new phenomena which have appeared in this temperature region, and by previously known phenomena which have become relatively more important. Incidentally, the rapid advance of this branch of physics is illustrated by the fact that most physicists would now confine the term 'low temperature' to the region within a few degrees of the absolute zero.

The book under review is written by experienced workers, and gives a very readable account of the whole range of low-temperature research, "mainly for physicists specializing in other fields". It commences with a history of gas liquefaction, followed by an account of the commercial liquefaction of air, and its rectification, an account full enough to include calculation of efficiencies of liquefaction processes, and the methods of 'rectification calculus'. (It is interesting to read in this connexion that Keesom has shown that the old Pictet process can be more efficient than either the Claude or the Linde.) This is followed by chapters on the laboratory methods of making hydrogen and helium, and on their use in the production of the low temperatures with which the book is mainly concerned. It is entirely owing to the recent improvements in the small-scale production of liquid helium that we owe the fruitful extension of its use to laboratories not originally equipped for work in this field. The non-continuous expansion method is even more adaptable than the reader would gather from the account here, as instead of the duration of the experiment being limited to "an hour or more", experiments lasting more than twelve hours are often carried out after a single expansion.

For work below about 1° K. we have to rely on other methods. So long as a property is changing with temperature, we can make use of this property (at any rate in principle) to attain yet lower temperatures. How the magnetic susceptibility of certain paramagnetic substances has been used for this purpose is described in a late chapter, in which is also included a clear description of the method of determining the temperatures reached on the absolute thermodynamic scale, particularly interesting as perhaps the only case in which its definition is directly applied. The inaccessibility, in the light of Nernst's Third Law, of the absolute zero is discussed in a useful chapter on that law. The importance of low-temperature measurements to processes in chemical industry is also stressed in this connexion.

The remainder of the book consists of a summary of the results of research in its principal branches, including chapters on liquid-solid equilibrium, thermal and other properties of the solid state, magnetic phenomena, and the remarkable properties of superconductors. Although there are excellent accounts of these last elsewhere, it seems a pity, in view of the appeal of this book to non-specialists, that the section here is not fuller. It is also to be regretted that there is no account of work subsequent to 1935, although a bibliography up to May 1937 is appended. But in spite of these defects and of a very few minor misprints, the authors are to be congratulated on the very successful fulfilment of their aims.

T. C. K.

The Revival of Agriculture:
a Constructive Policy for Britain. Prepared by a Committee of the Rural Reconstruction Association. Pp. 138. (London: George Allen and Unwin, Ltd., 1938.) 3*s*. 6*d*. net.

THIS book presents a policy for agricultural reconstruction, with a strong bias towards economic nationalism which the authors, like Signor Mussolini, prefer to call "realism". It gives a clear exposition of the case for national self-sufficiency based on planned agricultural organization, but tends to minimize the disadvantages that might accompany self-sufficiency. Not everyone will agree with the following sweeping statement (p. 125): "It is not arguable that the mere moving of goods backwards and forwards across the seas, though it gives employment to both men and capital, has in itself an economic value". One wonders whether the mere moving of apples from the orchard to the market and thence to the consumer could be dispensed with as easily as shipping, or whether the interposition of water makes all the difference to the necessity for distribution.

The main idea is that our national survival depends on getting more people back to productive work on the land and keeping them there in comfort and security. Few will contend the desirability of this object. The authors realize that it would involve very careful organization of both production and distribution, and full protection of the rural community against price fluctuations, slumps, etc. Much of the security, however, is to be purchased at the cost of the financial and commercial interests that in the past have certainly feathered their nests more effectively than has agriculture, which the authors rightly regard as the foundations of our civilization. It is the misfortune of foundations that they have no place in the sun. What the ultimate consequences to the whole structure of civilization would be of turning the foundations into pinnacles is a question which nobody can yet answer. G. V. J.

Coordinate Solid Geometry
Being Chapters I–IX of "An Elementary Treatise on Coordinate Geometry of Three Dimensions". By Prof. Robert J. T. Bell. Pp. xiii+175+xliii. (London: Macmillan and Co., Ltd., 1938.) 7*s*. 6*d*.

THIS book contains, as its text, the first nine chapters of Prof. Bell's well-known "Treatise on Coordinate Geometry of Three Dimensions". It therefore leads up to and completes the treatment of the central surfaces in order to meet the needs of those students who do not desire to study mathematics beyond a pass or general degree standard.

The author has made an interesting and appropriate selection of miscellaneous examples from his larger work and in addition has provided an entirely new set. An appendix has also been added in which alternative and simplified methods to several parts of the original text are given.

The book bears all the excellent features of the "Treatise" and should be of great use to the students for whom it has been prepared.

Silicate Analysis:
a Manual for Geologists and Chemists; with Chapters on Check Calculations and Geochemical Data. By Dr. A. W. Groves. Pp. xxi+230. (London: Thomas Murby and Co., 1937.) 12*s*. 6*d*. net.

THE chemical analysis of silicates is of importance not only in the pure sciences of geology, mineralogy and geochemistry, but also in many branches of technology and industry. The standard works in English on this subject are those of Hillebrand and Washington, and the methods of analysis described in this volume include many given by these workers. These standard methods, however, have been modified where the author's experience has shown such modification to be necessary and, further, other methods are given in detail. Great attention is paid to minutiæ of manipulation, and for ease of consultation the instructions concerning the procedure of the analysis are printed in large type.

After introductory chapters on the equipment of the laboratory, reagents, sampling, and routine operations, the main part of this volume deals fully with the normal methods of silicate analysis. The concluding chapters are devoted to such topics as special methods, analyses for industrial purposes, errors in silicate analysis, and the geochemical distribution of the elements.

This book, which is well produced, provides a detailed guide in silicate analysis for both chemist and geologist.

Modern Optical Projectors:
a Practical Handbook on the Principles and Construction of Optical Projection Appliances for the Lecture Room, Laboratory and Workshop. By Edgar T. Westbury. Pp. 124. (London: Percival Marshall and Co., Ltd., n.d.) 3*s*. 6*d*.

THERE is a decided place for this little book in lecture room, laboratory or workshop. As years have gone on, it is surprising what developments have taken place since the 'magic lantern' provided the only means of illustrating a lecture. Yet it remains the prototype of all the more or less elaborate instruments which are in common use to-day for such a purpose.

The information given by the author is severely practical, and covers the whole range of problems likely to arise in the construction and care of projectors. Two points are worthy of special mention. One is the need for absolute darkness during the exhibition of slides. It appears that some five candle-power of stray light on the screen is enough to spoil the effect of five-hundred candle-power of illumination from the lantern. This is common experience, but it is interesting to have figures. The other matter is the value of optical projection in the workshop, for example, in the testing of screw threads by casting a shadow of the screw upon the screen at the same time as an enlarged working drawing. Imperfections are readily revealed by this method. The book is well produced and liberally illustrated.

F. I. G. R.

Die mikroskopischen Boden-Pilze:
ihr Leben, ihre Verbreitung sowie ihre ökonomische und pathogene Bedeutung. Von Dr. Anneliese Niethammer. Pp. vi+193+6 plates. ('s-Gravenhage: Dr. W. Junk, 1937.) 13 florins.

IT is always a gratifying stage in the development of any department of science, when a large number of detailed investigations can be collected, correlated, and woven into a coherent philosophy of the subject as a whole. That stage has arrived in the study of soil mycology, and the monograph under review is worthy of the occasion. Literature upon the taxonomy of microscopic fungi which live in the soil has been comparatively unavailable. Dr. Niethammer's work collects it, and the mycologist whose studies have not hitherto been specifically related to pedology may now find his way with relative ease amongst the Phycomycetes, Ascomycetes and Fungi Imperfecti which provide the microscopic fungus flora of the soil.

The second part of the monograph reviews the distribution of these organisms in relation to world-wide geographical and climatic conditions, to soil types, and to the higher plants which grow thereon. This leads to a discussion of the life-histories of fungi under natural conditions, their pathology and chemical action upon various substances in the soil. Modern conceptions of growth-regulating substances are reviewed mycologically, whilst the relation of soil fungi to the practice of manuring is also discussed. Many new correlations are here possible, and a large amount of such information is included in the 73 quarto pages of detailed stocktaking which follow the 100 pages of taxonomy. The shortening of some generic names to their initial is sometimes disconcerting, whilst the further criticism of the paucity of plates and drawings is only emphasized by the high quality of the six which are included. J. G.

The Conservation of Prints, Drawings and Manuscripts
By Dr. H. J. Plenderleith. (Published for the Museums Association.) Pp. vii+66+5 plates. (London: Oxford University Press, 1937.) 3*s.* 6*d.* net.

THIS is the second member of a series of booklets issued by the Museums Association with the general idea of helping curators in their task of conservation of precious objects. It may be said at once that this purpose is admirably fulfilled by the pages now before us.

The scheme is, first to consider the nature of the materials in question—paper, parchment, inks and so forth—and then to discuss methods for cleaning and repair. Both physical and chemical processes are involved in this work. The crux of the whole matter is experience. Given that experience, a very modest equipment will enable it to be utilized to the full. The value of this manual is that it is the product of profound experience, presented in such a way that others may benefit from it, even if their resources are more limited than those at the author's disposal. A number of good illustrations are included.

F. I. G. R.

Electricity and Magnetism:
an Introduction to the Mathematical Theory. By A. S. Ramsey. Pp. xi+267. (Cambridge: At the University Press, 1937.) 10*s.* 6*d.*

"VIEILLE école, bonne école, hey?" said Major Pendennis, and the remark is irresistibly suggested by the contents and scope of a work which "covers the schedule for Part I of the Tripos", untouched and undismayed by the drums and tramplings of one knows not how many conquests. Here the student will find an old story admirably retold, and he who would learn to deal effectively with such problems as demand a good working knowledge of Laplace's equation, the method of images, distribution in networks of conductors, self- and mutual-inductance and the like, will find the president of Magdalene's volume an efficient and trustworthy guide. He will have much more to learn before he arrives at the confines of modern knowledge of electricity, but he will have nothing to unlearn, and a careful study of the book will provide him with knowledge likely to be of great help in his later studies. A. F.

Brompton Hospital Reports:
a Collection of Papers recently published from the Hospital. Vol. 6. Pp. iv+183+6 plates. (London: Research Department, Brompton Hospital, 1937.) 2*s.* 6*d.*

IN addition to three hitherto unpublished articles dealing respectively with multiple cystic disease of the lungs by Drs. F. H. Young and N. C. Oswald, an investigation of the relation of bronchography to post-lobectomy atelectasis by Mr. R. H. R. Belsery, and an investigation on statistical lines of the clinical aspects of senile phthisis by Drs. W. D. W. Brooks and F. P. Lee Lander, this volume contains papers which have been published elsewhere on perspective and poise in practice, and various aspects of pulmonary tuberculosis and other diseases of the chest. The index of authors for the first six volumes and the subject index for the first five are included. The annual report of the Hospital for 1937 is appended.

German for Students of Medicine and Science:
with Notes, Grammatical Introduction and Vocabulary. By W. F. Mainland. Pp. xlvii+160. (Edinburgh and London: Oliver and Boyd, n.d.) 8*s.* 6*d.* net.

THIS useful work is intended to relieve the irksomeness of learning German for the already overworked undergraduate, medical practitioner or lecturer in a medical school, who should welcome the unconventional method adopted. The book contains an indispensable minimum of grammar, a short list of German medical journals and a selection of passages from medical and lay writers, classified as easy, moderately difficult and advanced, and dealing with anatomy, histology, physiology, biochemistry, pathology and bacteriology, medicine, pharmacology, surgery, hygiene and dietetics, psychology and the history of medicine. A vocabulary is provided.

Further Evidence on the Structure of the South African Pleistocene Anthropoids

By Dr. R. Broom, F.R.S., Transvaal Museum, Pretoria

NO apology need be given for publishing to the world at the earliest possible moment all new evidence that is discovered which seems to throw additional light on the structure of the apes that apparently are related to the ancestors of man. Every month reveals some new facts of importance, and it seems to me better that these should be announced at once, than that they should be held back for perhaps years in the hope of publishing a detailed account.

Some weeks after the Kromdraai skull was discovered (see NATURE, Aug. 27, p. 377), I was fortunate in finding, in the same matrix as the skull and within a few feet of the spot where it was found, three bones of the post-cranial skeleton. These are the lower end of the right humerus, part of the proximal end of the right ulna, and a toe phalanx.

As will be seen from Fig. 1, the humerus resembles so closely that of man that some will doubtless be inclined to refer it to a species of man, and to consider the possibility of man having been associated with *Paranthropus*; and of course it is impossible to prove that the humerus belongs to the ape. Still, as in the caves at Sterkfontein and Kromdraai between 3,000 and 4,000 specimens have been collected and no tooth or bone of man has so far been discovered, and as this humerus was got close to the skull of *Paranthropus*, which in a number of points of structure is nearly man, I think it practically certain that the humerus not only belongs to *Paranthropus* but also to the type individual. Assuming that it is the humerus of *Paranthropus*, it is interesting to note that it is nearly human in all its characters, and that it differs markedly from the humeri of the chimpanzee and gorilla. From which we may infer as probable

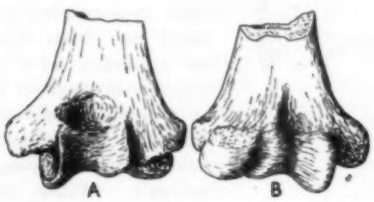


Fig. 1.

DISTAL END OF RIGHT HUMERUS OF *Paranthropus robustus* BROOM. *A*, POSTERIOR VIEW; *B*, ANTERIOR VIEW. HALF NATURAL SIZE.

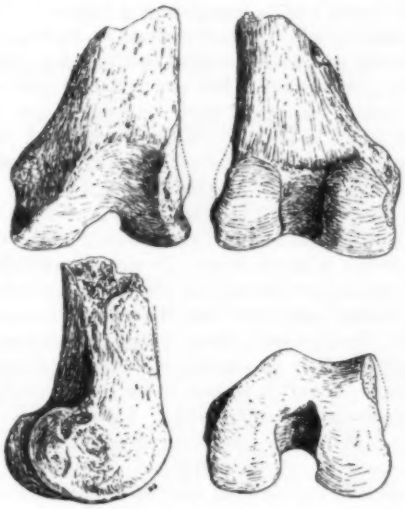


Fig. 2.

FOUR VIEWS OF DISTAL END OF LEFT FEMUR, BELIEVED TO BE THAT OF *Plesianthropus transvaalensis* BROOM. HALF NATURAL SIZE.

that *Paranthropus*, like man, was a bipedal animal, and that the arms were not used for locomotion, but for the manipulation of sticks and possibly tools.

Near the same spot was found part of the proximal end of the right ulna. It is not sufficiently well preserved to afford much evidence. It is nearly human.

The third bone which I believe to belong to the *Paranthropus* skeleton, though very small, is of great importance. It was also got at the same spot and within a few feet of the site of the skull. It is the distal phalanx of one of the toes, probably of the second (Fig. 4*C*). It is too short to be the ungual phalanx of one of the fingers, and it seems too long to be the ungual phalanx of a human toe. It seems to show that *Paranthropus* had toes like those of man but rather longer.

At Sterkfontein the distal end of a femur has been discovered which may be referred with very little hesitation to *Plesianthropus transvaalensis*. A little part of the external tuberosity is lost, but otherwise the fragment is perfect. The accompanying drawings (Fig. 2) show that it is nearly human in all its characters. The intercondylar notch is

relatively narrow, but not narrower than in a Bushman femur I have. The femoral fragment seems to indicate that *Plesianthropus* was also probably a bipedal animal.

The intercranial cast of the type of *Plesianthropus* shows that the cranial capacity is about 440 c.c. As the type skull is almost certainly that of a young female, it seemed probable that the male would have a larger cranial capacity. About six months ago, I was fortunate in finding a considerable part of the cranial cast of what I believe to be a male skull. Not far from the spot where the cranial cast was found, I obtained part of the skull of an old male. Most of the skull was so broken and crushed as to be of little value, but much of the left maxilla and malar are fairly well preserved. All the teeth except the last molar are worn down almost to the roots, and even the last molar is much worn. It seems probable that this upper jaw belongs to the same individual as the cranial cast and that the animal was an old male. Though only about half of the cranial cast is preserved, it is possible to make a satisfactory restoration, and it is seen to be very considerably larger than that of the type. I give figures on the same scale of the two cranial casts. I estimate the capacity of the supposed male skull to be about 600 c.c., but as less than half the cast is preserved and it is in part a little crushed, it is impossible to do more than make a rough estimate. The capacity can scarcely be less than 600 c.c. and may perhaps even be 650 c.c.

From Fig. 3 it will be seen that the supposed male cast is remarkably like that of *Pithecanthropus erectus*, and if von Koenigswald's estimate of the cranial capacity of his new skull as 750 c.c. be correct, our South African anthropoid ape is not very far behind this primitive human type.

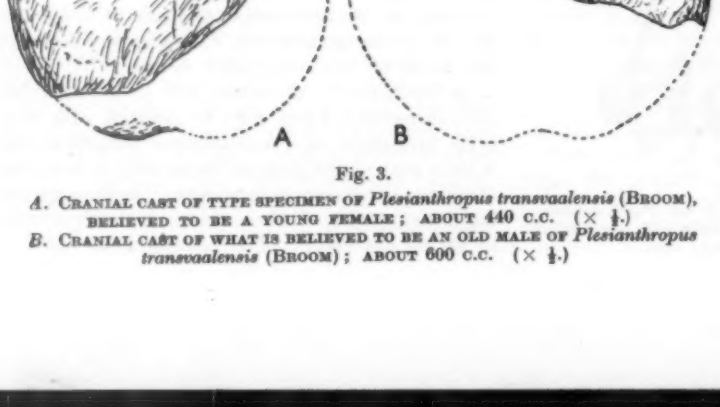


Fig. 3.

A. Cranial cast of type specimen of *Plesianthropus transvaalensis* (Broom), believed to be a young female; about 440 c.c. (× ½.)

B. Cranial cast of what is believed to be an old male of *Plesianthropus transvaalensis* (Broom); about 600 c.c. (× ½.)

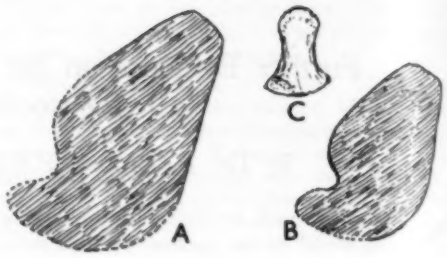


Fig. 4.

A. Section through mandibular symphysis of *Paranthropus robustus* Broom.

B. Section through mandibular symphysis of ten year old male child of *Plesianthropus transvaalensis* (Broom).

C. Terminal phalanx of toe of *Paranthropus robustus* Broom.

(All natural size.)

I give drawings (Fig. 4) of the symphyses of the mandibles of *Plesianthropus* and *Paranthropus*. The former is from the symphysis of a male child of about ten years of age. It is fairly complete, only the lower portion being lost. If this be compared with the symphyses of other anthropoids and of primitive human types, it will be seen that the only forms that approach it at all closely are *Dryopithecus* and the gorilla. The symphysis of the adult *Paranthropus* is less satisfactorily preserved, but it can be restored with considerable confidence. It is seen to be very massive—more massive than in any other known primate except the gorilla. There is no very close resemblance between the symphysis in the chimpanzee and those of our fossil anthropoids.

When the Sterkfontein ape was found, I considered the geological age to be probably Upper Pleistocene, as a number of horse teeth had been found in an adjoining cave and I considered those to belong to *Equus capensis*—a fossil horse which we know survived until comparatively recently. Within the last few weeks, we have obtained many much better preserved horse teeth from the same cave, and we now

find that though those belong to a large horse allied to *Equus capensis*, they cannot belong to this species. They will possibly prove to belong to *Equus harrisi*, a species which I named ten years ago from teeth found in the diamond gravels.

The positive evidence for *Plesianthropus* being Upper Pleistocene thus disappears. It must belong to some part of the Pleistocene, but we must wait for a more precise determination. Until we have more evidence, we may provisionally place both *Plesianthropus* and *Paranthropus* in the Middle Pleistocene, though they were not contemporaries; and the Taungs ape *Australopithecus* may be Lower Pleistocene or possibly Upper Pliocene.

Fine Structure of the Plant Cell Wall

By S. H. Clarke, Forest Products Research Laboratory

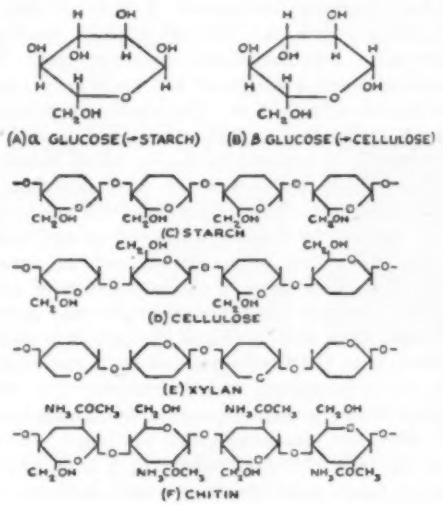
ALTHOUGH it is almost eighty years since Nägeli[1] introduced the micellar hypothesis to account for the anisotropy of certain plant structures, it is remarkable how nearly his original conception satisfies the most recent discoveries. It may be recalled that Nägeli pictured the cell wall as composed of ultra-microscopic particles to which he gave the name 'micelles', and which were regarded as discrete units, more or less like the bricks in a masonry wall. In order to explain the shrinkage of wood it was assumed that water entered or left the intermicellar spaces, pushing the micelles farther apart or allowing them to come nearer together, and the elongated shape of the micelles was held to account for the difference between longitudinal and transverse shrinkage; the optical anisotropy of the cell wall was referred to the optical properties of the micelles themselves. Some revision of Nägeli's statement was however found necessary, and a large body of workers rejected the conception completely, postulating instead a system of continuous or connected cellulose threads or layers. Neither conception is completely satisfactory and the modern tendency is to seek a compromise between the two. The position has been reviewed from the point of view of physicist, chemist and botanist[2,3,4,5], perhaps the fullest summaries being those of Frey-Wyssling[4*], which have been freely used in the present account.

The aim of the present account is not to offer a complete survey of the literature (the references quoted will lead indirectly to the more important contributions to the subject), but to give a fairly simple picture of the current conception of the different phases of cell wall structure. At the outset it must be realized that a complete picture is impossible as yet, because while the wave-lengths of visible and ultra-violet light only permit the accurate and direct observation of particles larger than about 2500 A., X-rays are only of value in studying structures of much smaller dimensions, and details between these two limits must be supplied largely by inference and conjecture.

* Dr. Frey-Wyssling kindly read the draft of this review.

The Cellulosic or Micellar System

Modern conceptions of cell wall structure rest on the recognition of cellulose as the skeletal, or 'framework', substance. The outstanding property of cellulose is a capacity for forming long, thread- or chain-like molecules, which are frequently arranged so as to be parallel to the cell axis. The



molecular weight, and therefore the length of the chain-molecules, have so far proved indeterminate; there is some evidence that they may not be constant, and several investigators have insisted that it is incorrect to speak of a 'cellulose molecule'. Although cellulose may be shown by X-ray examination to have a definite crystal structure, it has never been observed in a crystalline form.

It is insoluble in all the usual chemical solvents. Introductions to the chemistry of cellulose begin with reference to glucose, a hexose sugar existing in two forms (formulæ *A* and *B*), both of which may undergo condensation to form larger chain-molecules. Whereas the molecules of the α-form combine as represented conventionally in formula *C*, linkage in the β-form demands the rotation of alternate molecules through 180° (formula *D*). The higher degree of symmetry in the chains of β-molecules is apparently accompanied by a greater stability, and it is probable that on this rests the importance of the β-glucosidic cellulose as the fundamental framework constituent, while the less stable α-glucosidic molecules of starch occur as reserve materials, which are of a more temporary importance in the life of the plant. It is of great interest that xylan (a pentosan commonly occurring with cellulose in the cell walls of wood), and chitin (the framework substance of fungal cell walls) may have a fundamentally similar chain structure, as shown in formulæ *E* and *F* respectively; it has been suggested[6] that individual chain-molecules may include a variety of units, for example, glucose, xylose, glucuronic acid.

X-ray diffraction studies have revealed the dimensions of the spaces occupied by the individual glucose residues of the cellulose chain-molecules, and by the same method the length of the chains has been variously estimated at between 600 A. and 750 A., that is, 120–150 glucose residues. Viscometric determinations, however, give the chain-molecules a length of ten or twenty times that indicated by X-rays. The absolute legitimacy of both methods has been questioned, and it is not possible at present to decide which result is the more likely to be correct; there is reason to believe, however, that further light will be thrown on the subject by studies of the end groups of the chains which are being carried out in several laboratories. In spite of the contention of some investigators that the chain-molecules may extend unbroken from end to end of the cell, it is widely believed that the figures yielded by X-ray studies and by viscometric determinations are both approximately of the correct order of magnitude, and that the chain-molecules are much shorter than the cells. In this connexion, it is of interest that a fairly close relation exists between the strength of whole fibres and the length of the cellulose chain-molecules as revealed by the viscometric method[7]; it has been shown that maximum strength is reached in chains of about 2,000 glucose residues, and that further increase in chain length does not affect strength. Hydrolysis, such as accompanies the attack of certain fungi, results in the breaking of the cellulose chains into shorter units, and in a lowering of the tensile strength.

Plant fibres may be completely delignified without disintegration, so that the cellulose apparently forms a continuous system throughout the cell wall. It is also possible to remove the cellulose from the cell walls of some tissues, leaving behind what is presumed to be a continuous skeleton of lignin. In consequence, the cell wall is regarded as having continuous and interpenetrating systems of cellulose and lignin. The structure has been likened to reinforced concrete in which the iron strands represent the cellulose framework, and the concrete the lignin and other substances. From X-ray diffraction patterns, however, the impression is gained that the cellulose chain-molecules occur in discrete aggregates about 50 A. in diameter and more than 1000 A. in length. This impression is given by both dry and water-saturated material, and it would therefore appear that water penetrates between the aggregates without disturbing their internal crystal structure. In consequence they have been regarded as corresponding to micelles, and they are so named, albeit with a somewhat different meaning from that of Nägeli. The cellulose system is therefore visualized as continuous, and yet able to give the impression of being composed of discrete micelles when examined by X-rays.

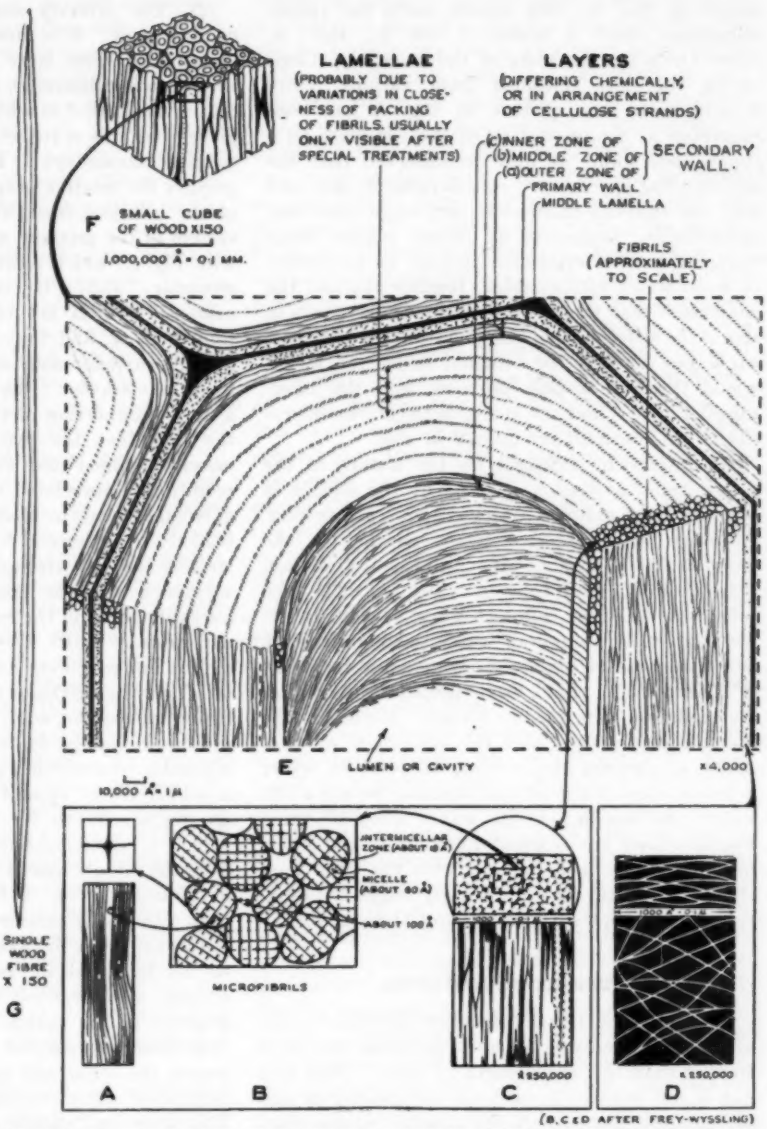
Fig. *A* illustrates a feasible conception of a molecular arrangement fulfilling these conditions. The cellulose chain-molecules are represented as lines which are not completely parallel, but show slight local variations in direction, so that here and there lens-shaped spaces occur between adjacent chains. There are, however, many zones in which the chain-molecules are parallel (indicated in Fig. *A* by thicker lines) and, since it is only such zones of regular arrangement that influence the X-ray diffraction patterns, the illusion of discrete aggregates is produced. Actually, the aggregates are linked by molecules which extend from one regular zone to another so as to maintain the continuity of the system. In Fig. *C* this condition is illustrated on a smaller scale; the white zones indicate the distribution of the cellulose, and the dotted lines the regions in which the chain-molecules are parallel. It may be observed from the dimensions given that the two illustrations (Figs. *B* and *C*) do not completely correspond. This lack of correspondence is doubtless explained by the fact that they were originally produced independently, and in all probability the intermicellar spaces and the larger capillaries actually intergrade continuously in size.

Adjacent glucose residues within a chain-molecule of cellulose are united by primary valences, but the nature of the attraction between laterally adjacent chain-molecules has not yet been fully elucidated. It is generally supposed, however, that the chain-molecules are united laterally by

van der Waals' cohesion. Frey-Wyssling mentions in criticizing the hypothesis of discrete micelles that this force must also be invoked in seeking to explain the attraction between micelles. It is clearly unsatisfactory to be compelled to resort to a single force to explain two distinct phenomena; for example, it is difficult to explain on such grounds why water only enters the intermicellar spaces and does not penetrate between the chain-molecules within the micelles.

The Intermicellar System

It is believed that the intermicellar system is normally occupied by lignin and related substances. Whatever their composition, these materials produce no effect on the X-ray diffraction pattern, so that they are apparently non-crystalline. Although they occupy a continuous system, the intermicellar materials appear to have little or no influence on the tensile strength of the cell wall; they bestow on the cellulose system, however, an increased rigidity, and incidentally increase the resistance to compression. Information regarding the intermicellar system has been obtained by impregnating cell walls with solutions of silver or gold salts, and precipitating crystals of the metals in the intermicellar spaces so as to make an impression on the X-ray diffraction pattern. In this way it has been



DIAGRAMMATIC REPRESENTATIONS OF CELL WALL STRUCTURE. Drawn by Miss M. S. Smith.

A. Cellulose chain-molecules, showing here and there zones of regular and parallel arrangement (the micelles indicated by X-rays).

B. Group of microfibrils, showing approximate relative sizes of micelles and spaces revealed by study of material impregnated with silver.

C. Cellulosic and non-cellulosic systems in the secondary wall. Cellulose white, non-cellulosic materials black; transverse section above, longitudinal section below. Large circle indicates approximate size of fibril at same magnification. (Note that the dimensions given by the author of Figs. B and C do not correspond exactly, but they serve to indicate the approximate sizes. The linking arrows have been inserted by the present writer.)

D. Cellulosic and non-cellulosic systems in the primary wall. Cellulose white, non-cellulosic materials black; transverse section above, longitudinal sections below.

E. Small piece of wood showing the relative sizes and dispositions of the cell wall constituents as revealed by microscopic examination.

F. Small cube of wood fibres magnified 150 times.

G. Single wood fibre magnified 150 times.

estimated that in their widest parts the spaces sometimes reach a width of 100 A., that is, about twice the diameter of the micelles. Combining the data obtained from various X-ray investigations the picture in Fig. *B* has been suggested as representative of the condition in a typical cell wall. It may be observed that the intermicellar spaces vary considerably in size, and that the micelles themselves are aggregated into 'microfibrils', separated by spaces rather larger than the usual intermicellar spaces. In his studies of wood-water relationships, Barkas[8] reached the conclusion that there is a continuous gradation in size of the space system, ranging from the botanical capillaries down to the colloidal structures, and it would therefore appear probable that the intermicellar spaces and the spaces between the microfibrils are continuously graded in size.

An interesting sidelight on the nature of the intermicellar system is afforded by the change in the refractive index of water entering the system. Although the refractive index parallel to the chain-molecule axis of dry cellulose by sodium light is 1·596, and that of water is 1·333, the refractive index of cellulose when swollen by 25 per cent of its volume of water is not noticeably less than that of dry cellulose, whereas an index of about 1·536 might be expected if the water and cellulose were merely mixed. Moreover, the volume contraction and the evolution of heat which accompany the swelling of wood by water indicate some form of combination between the water and the wood cell wall. Frey-Wyssling suggests that the original function of the intermicellar spaces is bound up with the growth of the cell wall, and that in the early stages of formation the protoplasm may occupy these spaces.

Microscopic Structure

The phases of cell wall structure described above are invisible because the units involved are much smaller than the wave-length of light. There is a gap in our knowledge between the microfibril and the smallest particles distinguishable microscopically, because no form of direct or indirect observation is yet available. We must now, therefore, turn to the visible structure built on the micellar framework.

Kerr and Bailey[9] have reviewed the nomenclature of the cell wall, marshalling the evidence that in typical cells the wall has three distinct regions (Fig. *E*):

(1) The *middle lamella*, or intercellular substance, is formed from the cell plate at cell division, and is shared by adjacent cells; it is very thin, completely isotropic and composed "largely, if not entirely, of polyuronides".

(2) The *primary wall* is developed from the cambial wall; it is anisotropic, and is composed of cellulose, with large proportions of hemicelluloses, pectic substances, and lignin. It is laid down during the period in which extension growth takes place, and this is reflected in the structure of the cellulose framework. Fig. *D* is an attempt to portray the relative proportions and arrangements of the cellulose framework and the intermicellar system of the primary wall, on a scale comparable with Fig. *C*, which represents the condition in the secondary wall. It may be observed that the cellulose strands are much more slender in the primary wall, and Frey-Wyssling suggests a more irregular arrangement as a consequence of growth by intussusception; the intermicellar zones occupy a larger proportion of the whole, in keeping with the fact that the primary wall is much more heavily lignified than the secondary wall. It will readily be appreciated that if the tensile strength of wood depends on that of the cellulose strands, it is likely to be limited by the zones in which these strands are least strongly developed, and it is not surprising that in green wood, tension failures normally occur in the region of the middle lamella and primary wall[10].

(3) The *secondary wall* is composed of cellulose, or of varying mixtures of cellulose, hemicelluloses, lignin, pentosans, etc. This wall is presumably produced mainly for mechanical reasons; it is incapable of extension growth, and during growth is added to by apposition. Three distinct zones are frequently to be seen: an outer zone (*a*) which is distinguishable in transverse sections from the middle zone (*b*), on account of a difference in refractive index. It has already been mentioned that cellulose is anisotropic, and the difference in refractive index between these two zones is due to the fact that in the outer zone the cellulose strands are arranged in a flat spiral (Fig. *E*), whereas in the middle zone they are as a rule approximately parallel to the cell axis. For this reason the outer and inner zones are readily distinguished when examined between crossed nicols. The outer and middle zones are usually identical or similar in composition, but there may be variations in the substances occupying the intermicellar spaces. In some cells an inner zone (*c*) is present, differing from the middle zone (*b*) in composition, and in that the cellulose units pursue a flat spiral (Fig. *E*).

Within this general scheme much variation is possible in different tissues, and in the cells of different species. In some cells no secondary wall is found, while in others it is very strongly developed and shows within itself elaborate zonations. Bailey and Kerr[11] illustrate fibres in the secondary walls of which the inclination of the

cellulose units alternates in several successive layers, reminiscent of the alternations in grain-direction in plywood. The same authors illustrate other fibres in which the secondary walls show several zones caused by variations in the intensity of lignification; these zones may be concentric, radial, or radio-concentric, and Bailey and Kerr have shown the arrangement to be influenced by geotropic or phototropic stimuli operating on the growing tree.

Zonations of the types described, due either to variations in chemical composition or to variations in the arrangement of the cellulose units affecting the optical anisotropy of the cell wall, are known as 'layers'. A much finer type of concentric zonation, termed 'lamellation', occurs in the walls of many plant fibres. Although it may accompany layering, lamellation is of a different nature and is not revealed microchemically or by polarized light. A single layer may include several lamellæ. Lamellæ may be observed in the thick-walled fibres of certain species when thin transverse sections mounted in liquids of suitable refractive index are examined at very high magnifications; they may be revealed also in the fibres of many other species when transverse sections are considerably swollen in dilute cuprammonia. From calculations based on their dimensions in swollen material, it has been estimated that in the natural state the lamellæ of the cotton hair are 0·4 μ (= 4000 A.) or less in thickness. In swollen sections each lamella is seen to comprise two concentric zones differing in brightness, and it is purely on account of these variations in optical density that the lamellæ are visible. It has been established that in the cotton hair the lamellæ are caused by diurnal fluctuations in light and temperature during the growing period[13], and although the methods used in studying the lamellations of cotton hairs cannot be applied to cells in other parts of the plant, it has been suggested that lamellation in xylem fibres is of a similar nature[13].

By means of controlled chemical and mechanical treatment[5,14], the cellulose wall may be dissected into tenuous threads known as 'fibrils'; these are of indeterminate length, and their diameter has been variously reported as between less than 1000 A. to about 5000 A. By further dissection the fibrils may be broken into smaller bodies described as dermatosomes, fusiform bodies, etc. the diameter of which is reported to be 5000 A. or less, and the length of which is from about 1000 A. to 1500 A. The descriptions of various investigators show discrepancies which are no doubt due to the observation of different tissues, of different species, to variations in the technique of dissection, and perhaps to variations in the degree of swelling at the time of measurement. All that can be said is that by dissection the wall can be broken into fibrils and these into smaller units. Bearing in mind that dissection is only accomplished as the result of severe chemical treatment, some reserve is necessary in attempting to construct from these units a picture of the cell wall in its original state. Nevertheless, the rough correspondence between fibril diameter and the dimensions of the lamellæ suggests that the separations are not entirely fortuitous. Bailey and Kerr[11] actually attribute the lamellæ to variations in the closeness of packing of the fibrils, or "in the number of fibrils per unit area" of cross-section. Some authors have suggested that the dermatosomes and the fibrils are coated with a non-cellulosic material, after the fashion of mortar in a masonry wall. If this be the case we are again thrown back on the properties of the mortar as the ultimate source of the tensile strength, whereas it has already been stated that there is much evidence for believing the cellulose to be mainly responsible. In this connexion it may be mentioned that Farr and Eckerson[15] have described what they believe to be the laying down by the protoplasm of minute particles of cellulose, coated with some pectic material which acts as a cement in the cell wall. Weighty objections to this view are summarized by Anderson and Kerr[12].

From microscopic evidence, then, we are able to say that the plant cell wall is ordinarily composed of concentric layers differing in the relative proportions of cellulose and other constituents. The layers appear to be built up of fibrils, long slender threads of cellulose the direction of which is often parallel to the main axis, but is subject to variation in different layers. The closeness of packing of the fibrils is subject to periodic fluctuation, as a result of which the cell walls frequently include a large number of extremely narrow lamellæ. The fibrils may be dissected chemically into small fusiform bodies or dermatosomes. It is inferred from the behaviour of suitably treated material that both the cellulose and the non-cellulosic constituents of the cell wall form continuous systems which are finely interpenetrating, and it is apparent that the cellulose system is mainly responsible for the tensile strength whereas the non-cellulosic constituents have a stiffening effect which results in increased resistance to compression. From X-ray evidence it is concluded that the fibrils are themselves composed of microfibrils which in turn consist of aggregates of micelles. The micelles are aggregates of cellulose chain-molecules. Each chain-molecule includes a large number of glucose residues, but it is not yet known whether the chains are of uniform length, or even of uniform constitution. In all probability neither micelles,

microfibrils, nor fibrils are discrete units, and their apparent independence is illusory and is due to peculiarities in arrangement that affect certain types of observation. It seems probable that the spaces between the cellulose units, such as might contain water, non-cellulosic wall constituents, or protoplasm at certain stages in the life of the cell, are of a continuously graded size, and may be regarded as the successive ramifications of a single system.

[1] Nägeli, C., "Die Micellartheorie". Edited by A. Frey-Wyssling. (Leipzig, 1928.)
[2] Anderson, D. B., *Bot. Rev.*, **1**, 52–76 (1935).
[3] Astbury, W. T., "The Fundamentals of Fibre Structure" (Oxford University Press, 1933).
[4] Seifriz, W., *Protoplasma*, **21**, 129–159 (1934).
[5] Frey-Wyssling, A., *Protoplasma*, **25**, 261–300 (1936); **27**, 372, 568 (1937); *Ber. deutsch. Bot. Ges.*, **55**, 119–132 (1937).
[6] Young, G. H., and Rowland, B. W., *Paper Trade J.*, **97**, 15–16 (1933) (cited by A. J. Bailey, *Mikrochimica Acta*, **2**, 35–36 (1937)).
[7] Staudinger, H., and Sorkin, M., *Melliand Textilber.*, **18**, 681–6 (1937).
[8] Barkas, W. W., *Proc. Phys. Soc.*, **48**, 576–588 (1936).
[9] Kerr, T., and Bailey, I. W., *J. Arn. Arb.*, **15**, 327–349 (1934).
[10] Clarke, S. H., *Forestry*, **9**, 132–138 (1935).
[11] Bailey, I. W., and Kerr, T., *J. Arn. Arb.*, **16**, 273–300 (1935); **18**, 261–272 (1937).
[12] Anderson, D. B., and Kerr, T., *Ind. and Eng. Chem.*, **30**, 48–54 (1938).
[13] Ritter, G. J., and Stillwell, C. W., *Paper Trade J.*, **98**, 37–40 (1934).
[14] Ritter, G. J., *Ind. Eng. Chem.*, **20**, 941–945 (1928); *Paper Industry*, **16**, 178–183 (1934).
[15] Farr, W. K., and Eckerson, S. H., *Contrib. Boyce Thompson Inst.*, **6**, 189–203 (1934).

Obituary Notices

Dr. C. C. Carpenter

THE technical press has paid tribute in full measure to the memory of Charles Carpenter, to his many outstanding achievements in the gas industry, to his ability to manage and to organize, to his intense consideration for his fellow workers as displayed in his zealous furtherance of co-partnership (see also NATURE, Oct. 8, p. 636). There remains the need to express something of the man himself, a difficult task with anyone but doubly so with one of his complex personality.

Dr. Carpenter was a far greater man than his contemporaries realize. His shyness, the habit of working alone which had developed almost to an inability to work with others, the reluctance to take part in those co-operative efforts which are so fashionable to-day, have collectively resulted in limiting the number of those to whom he was personally known during the later years of his life. Possibly to many of us now active in contemporary spheres, he has been a memory of past deeds rather than the present embodiment of an activity both mental and physical which his colleagues and intimates knew he had preserved until stricken by illness.

My friendship with him dates twenty-five years back when he was already distinguished and his habits formed. He had consented to become president of the Society of Chemical Industry at a critical time when the status of that industry in England had been brought low by neglect. Some of us were making a great effort to reform the Society, which we regarded as a potential instrument for progress, and to change its complacent attitude of parochial conservatism to one of vigorous action. Carpenter proved an ideal chairman at many difficult meetings and won the confidence of all by his firm and sympathetic handling of delicate situations. When it was realized that the troubles of the chemical industry could best be overcome by the formation of an entirely new Association of British Chemical Manufacturers, Dr. Carpenter was the obvious and universal choice for its first chairman. In this capacity he displayed his best qualities in the handling of the initial difficulties, including the reconciliation of conflicting interests, and so laid a firm and sure foundation for its future success.

This achievement, in sooth a considerable one, might have tempted Dr. Carpenter to continue collective industrial leadership at a time when leaders of his calibre were so much in demand, and he had many requests to do so; but the work was foreign to his real nature and he preferred to immerse himself wholly in the problems of his gas companies, to their great advantage.

Carpenter's qualities in his daily work have been emphasized by others. His attention to detail, the desire to find a reason for everything, the refusal to put up with anything but the best, his pertinacity to pursue a matter to the end, his remarkable power of continuous work and numerous other attributes combined to make him the personality he was during the long working day. The high standard he set for himself made him expect the same of others and caused him perhaps to be lacking in sympathy towards lesser mortals. This made him unduly severe when displeased and over-generous when giving reward. Hazlitt somewhere defines genius as the power of producing excellence; from this point of view, Carpenter certainly was a genius.

It was given to a few intimates to know Charles Carpenter on his artistic side. Evenings after dinner in his large comfortable room in Chelsea dwell in my memory. Spartan himself, he provided good cheer for his guests, and the range of conversation displayed a human personality remote from the austere chairman presiding in his board-room. The boon of artistic enjoyment makes itself manifest in many ways. To some it comes through the gradations of the bitten line, others find revelation in broader tone masses put on with a palate knife, more of us like my late father find intense happiness in colour. A class apart find supreme joy in the melodies of music, and

to these belonged Carpenter. He derived great pleasure from his gramophones ingeniously arranged to play both sides of a record consecutively without a break: the opera and concerts were his one relaxation and the only accepted reasons for his going out in the evening. His library was peculiar in more than one respect. He took great pride in the workmanship and binding of his books and regretted the decline in that craft. His tastes would be called old-fashioned: literature of the French sentimentalists and George Moore were among his favourites. He detested anything shoddy or imperfect.

This attitude is reflected in Dr. Carpenter's annual addresses as chairman, which instead of the usual platitudes contained studied discourses on matters of moment to the policy of the company, in which the meaning of every word had been weighed: an immense amount of time and trouble went to the preparation of these.

How shall we reconcile the dual characters; the shy sentimental music-loving artist with an intense sense of perfection and a hatred of shams; the reasoning intrepid engineer seeking to put into his creative work the artistic expression which he could not by his own hand achieve with pen or piano—the great leader setting so high a standard for himself that he felt he could not trust to others to execute his plans and so becoming lonely, unable to depute in the way that modern industry demands, carrying most of his burdens himself and in later years almost unwilling to be helped.

Each one of us is the integration of our many component parts, and who shall judge if the result is short of the ideal. Charles Carpenter was a great engineer, a cornerstone of the gas industry to which he devoted his life, the best of masters to his thousands of work-people, to whom more than anything else he brought fair dealing and security, and a complex and lovable personality to his intimates. We shall think of him at his best and remember how in life he did

> "Strive and hold cheap the strain;
> Learn, nor account the pang;
> Dare, never grudge the throe."

E. F. A.

Prof. W. H. Merrett

Prof. W. H. Merrett, formerly assistant-professor of metallurgy at the Royal School of Mines, who retired from his post rather more than a year ago, died after a short illness on October 29 last. He was sixty-six years of age. A fortnight before his retirement he had a severe stroke from which he never really recovered. It was followed by another, after an interval of little more than a year, which proved fatal.

Merrett received his school education at St. Olave's School, London, during which time he gained a number of valuable prizes for science, and obtained a Royal Exhibition of the Board of Education. In 1891 he entered the Royal School of Mines, and after spending three years there was awarded a first-class in the associateship of the School in metallurgy. This was during the tenure of the late Sir William Roberts-Austen of the professorship of metallurgy. In addition to holding this post, Sir William was chemist and assayer of the Mint, and it was there that he carried out his researches on metals and alloys. Thither Merrett proceeded after graduation and acted as an assistant in the prosecution of these researches during the next seven years. It was a particularly interesting period in the development of that branch of metallurgy which is to-day known as metallography. These were the early days of the subject and the foundations were still being laid. Roberts-Austen was himself one of the pioneers; he was a member of the Alloys Research Committee of the Institution of Mechanical Engineers and published five reports of experimental work in all. It is with the work for the fifth report that Merrett was particularly associated, acting as an assistant to Roberts-Austen and Stansfield.

The method of investigating the thermal inversions of metals and alloys at that time by taking cooling and heating curves was due to the late M. Osmond, using the thermo-electric pyrometer introduced by the late H. le Chatelier. In this method the co-ordinates were time and temperature and, while it was quite satisfactory in the upper ranges of temperature, it was not so suitable for the lower ranges where the rate of cooling becomes very slow. Roberts-Austen and Stansfield accordingly devised the 'differential' method, in which a neutral body was also present. (Strictly speaking it is not a differential but a difference method, since no differential coefficient is involved.) In this method temperature and difference of temperature were the co-ordinates, and accordingly the rate of cooling did not matter. Moreover, accidental fluctuations in the rate of cooling of the furnace were cancelled out. This method could be made very sensitive, and by its means accurate thermal curves of iron and carbon steels were obtained. In the Fifth Alloys Report is published a curve of a sample of electro-deposited iron which had cooled from 1150° to 100° C. It represented the most skilled piece of experimental work in this field at that time. In addition, this research contains a number of photomicrographs of steel structures of great clearness. Merrett developed a skilful technique in both these branches of metallography, which contributed very much to the value of the report in question. He was the first to apply the electric arc light as a method of illumination in the metallographic microscope. The Sixth Report to the Alloys Research Committee had been begun during Roberts-Austen's lifetime but owing to his illness and death it was completed by the late Prof. Gowland with the assistance of Merrett. This deals with the heat treatment of steel.

Roberts-Austen was also a member of a War Office and Admiralty Committee on Explosives and Ordnance. In this capacity he carried out a number of investigations, most of which were of a strictly confidential nature. These comprised (*a*) the nature of erosion in gun tubes, (*b*) the effects of various additions of nickel, chromium, tungsten and

manganese on the mechanical properties of gun steels, and (c) the effects of heat treatment on gun steels. Merrett carried out all the experimental work on which these reports were based. He conducted an investigation, also under Roberts-Austen, for the Board of Trade on the St. Neots railway disaster. This examination was published *in extenso* as a Blue Book in 1900, and the accident traced to a broken rail. He found evidence of a 'martensitic' structure, which is associated with great brittleness, on its surface. A temperature of at least 800° C. is required to produce this. Merrett was at least partly, if not wholly, responsible for a new lyddite shell exploder, for which a secret patent was taken out by the late Lord Haldane. He was also largely concerned with the development of ammonium nitrate for use as an ingredient of explosives, which led to the introduction of amatol.

In 1901, Merrett was appointed instructor in the Metallurgy Department of the Royal School of Mines, and spent the remainder of his professional life there until his retirement. He rose to the position of assistant professor. He was an admirable teacher, clear and inspiring. This side of his work appealed to him very much. He was always anxious that his students should conduct themselves with credit in their examinations, and this led him sometimes to take a kindlier view of their performances than the results warranted. As early as the age of sixteen years he showed his taste for military work and joined the 3rd Middlesex Artillery in 1888. He was transferred as a sapper ten years later to the newly-formed Corps of London Electrical Engineers. He rose to the rank of major and was mobilized for active service on July 29, 1914. During the Great War he was in charge of various coast defences and anti-aircraft units. Afterwards his scientific knowledge was made available to the Ordnance College as instructor in metallurgy, chemistry and explosives. In 1926 he retired from military service on reaching the age limit and was awarded the Territorial Decoration and Long-Service Medal.

Merrett was a member of many scientific societies, a governor of the School of Metalliferous Mining at Camborne and a member of council of the Institution of Mining and Metallurgy. The writer was a colleague of his at the Royal School of Mines for twenty-three years. He possessed qualities which made him one of the most delightful of fellow workers. Some of these, such as punctuality and reliability, could probably be traced to some extent to his military training. Others, such as his perfect courtesy, generosity and good temper, were natural to him. It is impossible to think that he had an enemy. His many friends mourn the loss of one of the kindest and most unselfish of men. H. C. H. C.

We regret to announce the following deaths:

Mr. J. F. Bailey, director of the Botanic Gardens, Brisbane, from 1905 until 1917, and director of the Botanic Garden, Adelaide, from 1917 until 1932.

Prof. E. M. East, professor of genetics in Harvard University, aged fifty-nine years.

Admiral Sir Herbert Purey-Cust, K.B.E., C.B., formerly hydrographer to the Navy, on November 11, aged eighty-one years.

News and Views

The Royal Society

His Majesty the King has been graciously pleased to approve the recommendations made by the Council of the Royal Society for the award of the two Royal Medals for the current year to Dr. F. W. Aston, F.R.S., in recognition of his discovery of the isotopes of non-radioactive elements; and to Prof. R. A. Fisher, F.R.S., in recognition of his important contributions to the theory and practice of statistical methods. The Council of the Royal Society at its recent meeting recommended the following for election as officers and council at the anniversary meeting on November 30: *President*, Sir William Bragg; *Treasurer*, Sir Henry Lyons; *Secretaries*, Prof. A. V. Hill and Prof. A. C. G. Egerton; *Foreign Secretary*, Sir Albert Seward; *Other members of the Council*, Prof. F. C. Bartlett, Prof. F. E. Fritsch, Prof. M. Greenwood, Mr. H. L. Guy, Sir Thomas Holland, Dr. A. D. Imms, Prof. C. K. Ingold, Prof. G. B. Jeffery, Prof. J. Mellanby, Prof. J. Proudman, Dr. F. L. Pyman, Prof. O. W. Richardson, Prof. W. W. C. Topley, Prof. D. M. S. Watson, Prof. R. Whiddington, Prof. R. Whytlaw-Gray.

Prof. Enrico Fermi

The Nobel Prize for Physics for 1938 has been awarded to Prof. E. Fermi, professor of theoretical physics in the University of Rome, and his work in connexion with artificial radioactivity induced by neutrons is specially mentioned in the award. Bombardment of the nucleus with neutrons is peculiarly effective in producing nuclear reactions because the neutron does not experience the strong electrostatic forces which oppose the approach of a proton or α-particle. Fermi in 1934 showed that most nuclei, even the heaviest which are most resistant to charged particles, are disrupted by neutrons with the formation of new radioactive nuclei. In the same year, he discovered that the effectiveness of neutron bombardment is greatly increased in the presence of masses of water or paraffin, and concluded that the neutrons are slowed down by collisions with hydrogen nuclei in these substances, and that the slow neutrons have a high probability of entering and disrupting nuclei. Prof. Fermi has, however, made other outstanding contributions to atomic physics. In 1926 he applied Pauli's exclusion principle to deduce a

new kind of statistics for electrons (Fermi-Dirac statistics). He applied this to the assemblage of electrons in an atom (Thomson-Fermi atom model), and it has become the basis of the modern theory of electrons in metals. In 1934 he devised a theory of β-decay, starting from the view that a β-particle is emitted when a neutron in the nucleus turns into a proton. The distribution of energies in a continuous spectrum requires that a neutral particle (neutrino) be emitted with the β-ray. This theory has formed the starting point for many more recent discussions. Fermi has also published work on spectroscopy, on quantum electrodynamics, and, with Rossi, on the deflection of cosmic rays in the earth's magnetic field.

Dr. W. D. Lang, F.R.S.

Dr. William Dickson Lang, who retires from the keepership of geology in the British Museum (Natural History) at the end of the year, has made notable contributions both to palæontology and to geology. While occupied with curatorial duties he has studied especially polyzoans and corals, and in classifying them he has always sought for underlying principles. Like palæontologists studying other groups, he soon recognized parallel lineages in the evolution of these fossils as he traced them through geological time, and he found corresponding grades in the same order in each parallel lineage, showing that there was a definite common trend, as he termed it. Natural selection, therefore, did not work on indefinite individual variations but on trends which were 'orthogenetic' or in a certain fixed direction. Dr. Lang contributed several valuable papers on this subject to the *Proceedings of the Geologists' Association*, and he summarized his results in discussions at the centenary meeting of the British Association in 1931.

Dealing with animals which retained the complete skeleton of a lifetime in each individual, Dr. Lang could also study the growth stages, and he was convinced of the truth of the doctrine of recapitulation (the immature stages of an organism repeating more or less exactly the adult stages of its ancestors). He described it as "a guiding principle" for palæontologists. Dr. Lang also recognized that the calcareous skeleton of the polyzoans, when once started in a lineage, often proceeds to superfluity and eventually leads to extinction. He treated this subject in a memoir in the *Philosophical Transactions* in 1919, and in two valuable volumes of the British Museum Catalogue of Cretaceous Polyzoa, 1921–22. Dr. Lang spent many vacations in studying the succession of zones in the Lias of the Dorset coast. In 1924 he contributed to the *Proceedings of the Geologists' Association* a remarkably detailed map of these formations, and during more recent years he and other specialists have made a detailed examination of the fossils he collected. His interests have always been varied, and during the Great War he investigated insects which spread disease, eventually preparing an exhaustive "Handbook of British Mosquitoes", which was published by the Trustees of the British Museum in 1920.

Prof. A. V. Hill, O.B.E., F.R.S.

The Guthrie Lecturer of the Physical Society this year was Prof. A. V. Hill, Foulerton research professor and secretary of the Royal Society, who chose as the title of his lecture delivered on November 11 "The Transformations of Energy and the Mechanical Work of Muscles". Prof. Hill is a Cambridge man, where, under Langley, he devoted two years to research on the heat produced by living tissues. Here Hill found a congenial and stimulating environment, for those working in the laboratory at the time included such well-known figures as Anderson, Barcroft, Fletcher, Hardy, Hopkins and Keith Lucas. Prof. Hill's success may be said to be due to his appreciation of the basic essentials of a problem, to his knowledge of the methods by which such problems may be solved, to his ability to design the apparatus required by such methods, and lastly to his skill in constructing the necessary apparatus himself. A first-rate athlete, he was specially interested in the physiology of athletics. It was he who showed that energy is developed in muscle at two different times during a single contraction. Two pieces of apparatus have entered largely into these studies, namely, extremely delicate thermopiles and galvanometers which have a short period and great sensitivity. While the study of energy of contraction of muscle has been Hill's main line of research, a number of branch lines have interested him from time to time, mostly on biophysical subjects; for example, the measurement of small differences of osmotic pressure and the heat produced in nerves during the passage of impulses. During the Great War, Hill was director of research on anti-aircraft defence. In 1920 he became professor of physiology in Manchester, and in 1923 professor of physiology at University College, London. Prof. Hill has been honoured by several foreign universities and learned societies, and in 1922 he received the Nobel Prize for Medicine.

Energy Transformations in Muscles

In his Guthrie Lecture on the subject, Prof. A. V. Hill pointed out that the study of the heat given out by muscles in relation to the work done by them is one of the classics of physiology. Until recently, however, the matter appeared much more complicated than it really is, owing to technical difficulties. These have been overcome by the use of a very rapid recording system and an insulated thermopile only 0·002 inch thick. Some very simple relationships have now emerged. An active muscle liberates energy in three forms: in maintaining a contraction, as heat; in shortening, as heat; in shortening against load, as work; its behaviour in any circumstances is deduced from the resultant of these three. *Rate* of total energy liberation of a muscle is determined by the load upon it, increasing as the load decreases. This allows a simple equation to be deduced for the relation between speed and load. The constants of the equation are the same whether they are obtained by thermal or by mechanical measurements. The fact that a muscle does less external work when shortening at a higher speed has led to the hypothesis that muscle is endowed with 'viscosity', attributed

to a lag in the rearrangement of its molecules, as the external form of the contractile elements changes. This viscosity hypothesis is, however, altogether unnecessary; for the decrease of force and work with increased speed can be deduced from the manner in which the energy liberation is regulated. Some applications were also described. The maximum power developed by a muscle is with a load about three tenths of the maximum load it can bear. The highest efficiency (work/total energy) is with a load of about 0·45 of the maximum. These are near enough for maximum power and maximum efficiency to occur very nearly at about 37 per cent of the maximum load. These results obtained with frog's muscle almost certainly apply, though possibly with different constants, to man, and it would be very important to find out and to determine the constants of human muscle. The technique required would be a very different one.

Anthropoid Evolution in South Africa

Dr. Robert Broom continues to provide sensational news from South Africa for anthropologist and palæontologist. In another column of this issue (see p. 897) he reports further finds of relics of South African fossil anthropoids, which, if anything, surpass in interest the remarkable discoveries he has already recorded recently in these columns. From the site on which was found the Kromdraai skull, he has now recovered three bones, or parts of bones, the right humerus, the ulna and one of the toe-phalanges of *Paranthropus*, which, as his nomenclature indicates, he places, on the evidence of the skull, very near the line of man. The new evidence fully bears out his conclusion, for as he states, these bones, which on the balance of probabilities must be associated with the skull, are "nearly human". Further, and this is the most interesting feature of the discovery, they, and more especially the toe bone, must be interpreted as pointing to *Paranthropus* having walked erect. In other words, the upper limbs of this type were already freed from the duties of locomotion to undertake those functions which were to play a predominant part in forwarding the development of the specific characters of the brain of *Homo sapiens*.

This eminently reasonable interpretation of the Kromdraai finds removes the element of surprise from the further discoveries from Sterkfontein, which Dr. Broom records; but it adds to their significance in mutual corroboration as between the two series of discoveries. At Sterkfontein, on the site on which he had previously discovered *Plesianthropus transvaalensis*, an advance towards the human on Prof. Raymond Dart's *Australopithecus*, or ape-man from Taungs, Dr. Broom has also found the distal end of a femur and part of the brain cast of, it is argued, a mature male. Not only would the fragment of femur suggest that this type of fossil anthropoid also had attained bipedal status, but in addition the brain cast, when reconstructed, would place the capacity of the brain of *Plesianthropus* next in the scale of measurement, so far as at present known, to the recently discovered specimen of *Pithecanthropus* from Java. *Pithecanthropus*, no longer in danger of being classed as a gibbon, is definitely above the human border-line. The new evidence from Kromdraai and Sterkfontein, taken in conjunction with the evidence of the symphyses, which Dr. Broom further records, would indeed seem to afford warrant for the view that we have been given a glimpse of the evolutionary process at a moment when what has been regarded hitherto as man's prerogative, the permanent assumption of the erect posture, had not long taken place. The difficulty in the way of regarding the South African fossil series as forming part of the human evolutionary process, though of course significant by analogy, on the ground of its relatively late date, to which Sir Arthur Keith has directed attention, is reduced, though not eliminated, by Dr. Broom's evidence for a revised dating.

Scientific Associations of the Lubbock Estate

The public acquisition of the High Elms estate in Kent, as part of London's 'green belt', is an event of note in the history of science; for this was the home of the Lubbock family from 1808. In that year, Sir John William Lubbock acquired the nucleus of the property, some 270 acres; by later accretions the estate reached its present extent of nearly a thousand acres. A second Sir John William Lubbock was the first to bring scientific fame into the annals of the family: his observations of tidal and lunar phenomena and in physical astronomy ranked him high, and he was elected fellow of the Royal Society when barely twenty-seven years old. He worked also on the mathematical doctrine of probability and applied it practically to the subject of life assurance. He became the first vice-chancellor of the University of London. He built the present mansion of High Elms, extended the property, and greatly beautified it by planting many of the splendid trees which grace it now. He was followed by a still more famous son, Sir John Lubbock, afterwards Lord Avebury, who, born in 1834, spent nearly all his life there, and succeeded to the property in 1865. It is well known that on the scientific side his extraordinary career was influenced, not only by his father, but also, profoundly, by Charles Darwin.

In fact, the assurance of the preservation of High Elms rounds off, as it were, a unique scientific memorial. For Down House is less than two miles from High Elms, and Down House, as is well known, is preserved as a memorial to Darwin by the gift of Sir Buckston Browne to the British Association. It is on record that Sir John William Lubbock hailed as a great event the news that Charles Darwin was coming to live at Down House in 1842, and it was not long before intimacy was established between the two houses. Between Darwin, in his thirties, and John Lubbock, not yet in his teens, a close friendship grew and endured until Darwin's death in 1882, when Lubbock paid final tribute to his scientific master by drawing up the memorial which petitioned the Dean of Westminster that Darwin should be buried in the Abbey. It is good to know that not

only the homes of these two renowned men, but also some at least of the countryside which they knew and loved, are safe from future change though suburban London lies so near.

Jubilee of the Pasteur Institute, Paris

NOVEMBER 14, 1938, marked the fiftieth anniversary of the inauguration of the Pasteur Institute of Paris as the result of international subscription, but the actual celebrations have, owing to the recent crisis, been postponed until December 27, the anniversary of the birth of Pasteur. The spacious building in the Rue Dutot, recently re-named Rue du Dr. Roux, took the place of the small laboratory in the Rue d'Ulm where so much of Pasteur's valuable work had been carried out. Although his labours were interrupted by ill-health during the rest of his life, he received the assistance of a number of collaborators and pupils, notably Roux, Yersin, Metchnikoff, Chamberland and Calmette. The institute at once became an important centre for bacteriological research, the results of which were published in the *Annales de l'Institut Pasteur*, founded in 1887, in which epoch-making papers appeared on rabies, anthrax, diphtheria toxin and antitoxin, and experimental syphilis, among many other important subjects.

IN 1903 the *Annales* were supplemented by the *Bulletin de l'Institut Pasteur*, which contained, as the title indicated, reviews and summaries of work on bacteriology, medicine, general biology, physiology and biological chemistry in relation to microbiology. The close association of the Institute with clinical medicine was shown by the subsequent establishment of the Pasteur hospital for infectious diseases on the opposite side of the street. Pasteur died on September 28, 1895, and after a public funeral was laid to rest in a magnificent tomb in a crypt of the Institute. Since his death, three eminent men have been in charge of the Institute, namely, Emile Duclaux (1895–1904), Emile Roux (1904–1933) and Louis Martin, the present director. Metchnikoff, Chamberland and Calmette were for some time sub-directors. Numerous Pasteur institutes modelled on that of Paris have been built in different parts of the world, such as those at Saigon (1889), Tunis (1893), Lille (1895), Algiers (1910) and Athens (1920).

Violent Earthquake of November 10

IT is reported from the Air Ministry that an earthquake of great violence was recorded on November 10 at Kew Observatory at 20 h. 30 m. 7 s. G.M.T., a second movement following about half an hour later. The displacements of the ground at Kew were about one tenth of an inch, and the epicentre of the shock was 5,100 miles away. This earthquake has been reported from observatories throughout the world. From New York it appeared to be at a distance of 3,400 miles and from Pasadena where the needles nearly went off the paper of the recording seismographs it appeared to be 2,550 miles. From the Dominion Observatory, Wellington, New Zealand, the epicentre appeared to be distant 6,000 miles, and from the Villa Ortoza Observatory in the Argentine more than 6,000 miles. At Mr. J. J. Shaw's Observatory at West Bromwich, it was reported to have had the largest amplitudes recorded in thirty years and to have been of greater violence than the Quetta earthquake of 1935 or the Tokyo earthquake of 1923. The shock was felt by people in Alaska though no damage was done, and it is reported in the *Yorkshire Post* to have been felt in Leeds. A small seismic sea wave was apparent on some of the Hawaiian Islands. All this evidence seems to point to a submarine epicentre in the North Pacific Ocean near the Aleutian Islands and to the south-west of Alaska. This area is known to be one of the unstable regions of the earth, about fifty large and many more small earthquakes being recorded from the vicinity between 1913 and 1930.

Earthquake near Vienna

AN earthquake, with an epicentre near Vienna, occurred about 4h. G.C.T. on November 8, doing some damage to property, but causing no casualties. An earthquake in this region is most unusual, and the last one of any importance was in 1927 on October 8 at 19h. 48m. 55s. G.C.T. with epicentre lat. 48° 04′ N., long. 16° 35′ E. It was discussed very thoroughly by Dr. V. Conrad, of Vienna, who confirmed from the records the existence of the P^* and S^* waves. He considered that the depth of focus was near 30 km., and that the thickness of the Granitic layer in this region was of the order of 40 km. Further, Conrad found a pulse which he thought was caused at the A. Mohorovičić discontinuity 60 km. deep under the earth's surface. It will be interesting to see whether or not these findings are confirmed by the present shock.

Inventors and Inventions

SIR JAMES SWINBURNE, in his presidential address delivered on October 25 to the Institute of Plastics, discussed the subject of invention. In his opinion, inventions are usually the work of men less than forty years of age and often are discovered by those without scientific training. He attributed this apparent anomaly to the likelihood of the technical man allowing his thought to be constrained in narrow grooves. The specialization of the modern world works against the interests of the home inventor. The day of the lone inventor has passed and progress is now usually the result of co-ordinated efforts of large research departments. Some of the greatest inventions have been, as a far-seeing judge once put it, what any fool might have done, but had not. Differentiating between the independent or outside inventor and the inside or technical man, Sir James believes that the latter is the former's chief enemy. When the independent worker approaches a commercial concern with an invention, he meets with opposition from the technical representative of the company, who is inspired by the human instinct of self-preservation, for the device submitted is something which the staff man feels that he himself ought to have thought of. A further distinction was drawn between the qualities necessary for an executive and

those for a technical man. Sir James epigrammatically stated that the object of patent law is to help industry by encouraging progress, by checking progress at each step; in other words, if there were no patent law and invention continued at its present rate, industry would progress faster; on the other hand, if there were no rewards for invention, the incentive to invent would almost disappear. In his opinion, the cost of patents is too high, and the legal expense entailed in fighting an infringement favours the large company. The appeal system gives rise to anomalies. Thus, the first judge may decide against a patentee, the appeal judges may agree with him, and finally three out of five in the Lords of Appeal might uphold the patentee's claim. We then have the curious position of three judges overruling six.

History of Iron Founding in England

At the annual general meeting of the Newcomen Society on November 9, Mr. W. A. Young was elected president for the ensuing year. The membership of the Society now stands at 870. After the conclusion of the business, the first part of a paper by Mr. Rhys Jenkins was read entitled "Iron-founding in England, 1490–1890". Though there are objects of cast-iron to be seen in museums, probably made 1,500–2,000 years ago, iron-founding in Europe as a regular trade is of comparatively modern origin. In Great Britain iron-founding followed the substitution of the primitive hearth, the bloomery, by the high furnace, known as the blast furnace. Sussex was the cradle of English iron-founding and there is a reference dated 1490 to a payment on behalf of the Archbishop of Canterbury to "ye Ierne founders of Buxstede". The industry was based mainly on the production of war material, though there was a certain amount of production of chimney backs, fire dogs and grave slabs, and also of gear for the forges. King Henry VIII came to the throne in 1509 and he at once set about the provision of armament. He brought over foreign workmen to cast bronze guns, and a year or two prior to his death the first cast-iron guns were made. The credit for initiating this departure belongs to William Levet, the parson of Buxted. In the early days of Elizabeth, an export trade in cast-iron guns commenced. Guns were sent to the Low Countries, France and Germany, and in 1582 Portugal took no fewer than 132 pieces. In 1601 it was stated the total output was about 800 tons per annum. The earliest account of any real value of the methods of casting guns is given by Sirurey de Saint Remy in his "Memoires d'Artillerie" published in Paris in 1693.

Structure and Strength

The seventh Andrew Laing Lecture, delivered by Sir William Bragg before the North-East Coast Institution of Engineers and Shipbuilders at Newcastle on November 8, dealt with the molecular basis of the strength of materials. Taking carbon compounds first, he showed how the regular arrangement of the carbon atoms in the diamond as determined by modern X-ray analysis accounts for its hardness, how long chains of such atoms with side atoms of hydrogen lead to paraffins, the tendency of which to set themselves parallel to each other like corn stalks in a field leads to their slipperiness, and how chains modified by oxygen atoms at one end lead to oils with lubricating powers. Another arrangement of carbon atoms in a plane leads to graphite sheets, which again can slide over each other and also possess lubricating powers. More complicated chain structures give celluloses of many kinds as found in plants, and a combination of benzene rings with oxygen gives plastics like bakelite. The atoms of metals and alloys are in general packed together like spheres, and the properties of the product depend mainly on the sizes of the atoms constituting it and the number of electrons they can put into the common stock.

The Science Museum: Recent Acquisitions

The inventor's working model of the first calculating machine capable of multiplying sums of money in sterling currency (£.*s.d.* and fractions of a penny) has been presented to the Science Museum. The present machine, invented by Mr. E. C. McClure in 1934, requires only one turn of the handle for each digit in the multiplier, so that to multiply any sum of money by a number less than a thousand it is necessary to make only three turns of the handle. The principles embodied in the machine are being used in a new sterling multiplying punch which is being manufactured by Messrs. Powers-Samas Accounting Machines Ltd., who have given the model to the Science Museum. A collection of trade cards issued by English instrument makers to advertise their products, presented by Mr. Thomas H. Court, has recently been placed on exhibition; they are mostly of the eighteenth century and are of considerable historical interest and importance. The Museum has acquired a large-scale working model of the escapement employed about 1880 in the original Waterbury watches, which were among the first really cheap watches to be made. The group of hearing aids illustrates developments since 1930; of special interest are the widely contrasting valve amplifying sets of 1932 and 1938.

Radio Valve Data

Each year the *Wireless World* performs a very useful function in providing comprehensive details of all the thermionic valves available in Great Britain. The issue of November 10 contains a Valve Data Supplement listing more than 1,000 different valves in twenty pages of tables. All types of valves are dealt with, whether these be used as rectifiers, frequency changers or amplifiers; and while some of those described may be becoming obsolete, it is necessary to include them as they are used for replacement purposes in existing radio sets or amplifiers. In general, the valves are listed in order of filament or heater voltage, and the variation in this voltage is one of the reasons for the large number of valves it is necessary to describe. Valves for battery operation have filaments for 2-volt working, while

4-volt types are used for A.C. mains operation; the 6·3- and 13-volt types are intended either for universal use on A.C. or D.C. mains, or for use with 6- and 12-volt motor-car batteries respectively. Fortunately, the number of valve bases is not yet equal to the number of valves, but fourteen different bases are listed, of which seven types are in common use in Great Britain, and the text explains that these seven may be connected up in 144 different ways. It is much to be regretted that those responsible for the design and manufacture of valves have not seen their way to bring about some measure of standardization; but in the chaos that exists, the valve data supplement referred to above should prove a useful guide.

Co-ordination of Medical Services

A DEPUTATION from the central emergency committee of the British Medical Association, including representatives of the Royal Colleges, was received on November 8 by Sir Thomas Inskip, the Minister for Co-ordination of Defence, who was accompanied by officers of the Government departments concerned. The deputation urged the establishment of machinery for the co-ordination of all medical services for the civilian population under a single body, and the co-ordination of civilian medical organizations under that of the Service Departments. It was also proposed that the machinery should be closely associated with the central emergency committee as being representative of all branches of the profession.

A New Chemical Periodical

A NEW periodical entitled *Chemical Products and the Chemical News*, which is being published monthly by Science Services, Ltd., 35 Great James Street, Bedford Row, London, W.C.2, is designed to emphasize the indivisibility of the chemical industry. It will accordingly deal with matters of interest to the chemical, drug, pharmaceutical and cosmetic industries, and particularly the new uses to which chemical products and related materials are being put and their future place in industry and in the framework of the modern world. In this policy, *Chemical Products* claims to be in the lineage of the *Chemical News* of Sir William Crookes. The first number (October) includes an article by Dr. E. R. Weidlein, director of the Mellon Institute, on industrial progress, in which developments in the fields of synthetic resins, lubricants and fuels, carbon black, plant stimulants, etc., in which that Institute has been concerned, are reviewed. In other articles A. L. Bacharach reviews the influence of laboratory on manufacturing technique, and C. W. D. Stafford describes the preparation and uses of liver extracts. Dr. W. Langer deals with the formulation of cosmetics, and Dr. C. I. B. Voge with that of mouth washes. An interesting account of the House of Roche is also included, together with the brief views of such eminent chemists as Prof. J. F. Thorpe, Dr. Joseph Needham and Dr. E. F. Armstrong on the nature, scope and policy of a chemical journal.

Colonial Service: Recent Appointments

THE following appointments have recently been made: F. J. Harper, agricultural officer, Nigeria; G. A. Jones, director of agriculture, Jamaica; F. H. Fitch, geologist, Malaya; T. G. Chamberlain, veterinary officer, Kenya; D. Slavin, veterinary research officer, Kenya; J. F. C. Swan, veterinary officer, Northern Rhodesia; D. M. Hanschell, assistant botanist, British West Indies Central Sugar Cane Breeding Station, Barbados; W. A. Hughes, inspector of plants and produce, Gold Coast; J. Sheard, sleeping sickness control officer, Nigeria; O. T. Faulkner (director of agriculture, Malaya), principal, Imperial College of Tropical Agriculture, Trinidad (seconded); J. D. Gillespie (agricultural superintendent, British Guiana), agricultural officer, Sierra Leone; B. J. Hartley (district agricultural officer, Tanganyika Territory), agricultural officer, Aden; J. F. Ward (agricultural officer, Nigeria), agricultural officer, British Honduras; A. Cawley (engineering geologist), inspector of mines, Tanganyika Territory.

Announcements

SIR WILLIAM BRAGG, president of the Royal Society, is to deliver an address on "The Advance of Science" at the Ely Diocesan Conference to be held at Cambridge on November 21.

DR. H. SPENCER JONES, Astronomer Royal, will deliver the fourteenth annual Norman Lockyer Lecture under the auspices of the British Association at the Goldsmiths' Hall, London, E.C.2, on Tuesday, December 6, at 4 p.m. The subject of the lecture will be "The Atmospheres of the Planets".

DR. HANS HOLFELDER, professor of general clinical roentgenology at Frankfort-on-Main, has been awarded the Albers-Schönberg Medal by the German Röntgen Society.

A SERIES of open meetings on "National Defence" has been arranged by the Scientists' Group of the Left Book Club; the meetings are being held at the University Labour Club, 101 Great Russell Street, London, W.C.1, on Mondays at 8.15. Among the topics and speakers are: aerial warfare, by F. W. Meredith, food supplies in war time, by F. Le Gros Clark, the medical services, by Dr. D. Stark Murray and national defence and the scientific worker, by Prof. J. D. Bernal. Particulars can be obtained from the secretary of the Group, 175A Highbury New Park, London, N.5.

ACCORDING to a special health commission, Poland, which ought to have 25,000 medical practitioners, has only 12,000, there being about 3·7 per 10,000 inhabitants. 61 per cent are settled in 28 towns which contain only 13·5 per cent of the total population. In order to provide medical attention in rural districts a law is being prepared to compel every medical practitioner to practise in the country for his first two years.

Letters to the Editor

The Editor does not hold himself responsible for opinions expressed by his correspondents. He cannot undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*

NOTES ON POINTS IN SOME OF THIS WEEK'S LETTERS APPEAR ON P. 919.

CORRESPONDENTS ARE INVITED TO ATTACH SIMILAR SUMMARIES TO THEIR COMMUNICATIONS.

A Palæolithic Industry from the Cromer District

INVESTIGATIONS by us during the last four years, supported by grants from the Percy Sladen Memorial Fund, have shown that a hitherto unrecognized flint industry occurs in the coast section at Corton, near Lowestoft, and in the neighbourhood of Cromer.

From the geological point of view, these particular implements occur in the marine sands at Corton which were classified by Searles Wood as "Middle Glacial", and in the shelly sand and gravel in the Cromer coast section which was correlated by Clement Reid with these Corton Beds. They have not so far been found in the underlying glacial deposits at either locality, but the same flint industry is also found in certain unfossiliferous gravels which are exposed in inland sections near Cromer, and further work is needed to prove the relationship of these gravels to the marine sands.

We have made a collection of Mollusca from the shelly sand near Cromer, especially at West Runton Gap, and a comparison of these shells with those of the Corton Beds is satisfactory so far as it goes, in showing that the West Runton fauna is more like that of the Corton Beds than that of any other known deposit. The shells show certain differences from those found in such older deposits as the Norwich and Weybourne Crags, and we are accordingly in agreement with the contentions of Searles Wood and Clement Reid that they are indigenous to the deposits in which they are found, and not derived. The geological side of the work has also shown that there is no real discrepancy between the stratigraphical successions at Corton and Cromer respectively. Whereas the marine sands at Corton are intermediate between the "Lower Glacial" deposits (of Searles Wood) and the "Chalky-Kimmeridgic" Boulder Clay (of F. W. Harmer), those at Cromer are younger than the North Sea Drift (North Sea Glaciation of Solomon), and it has now been proved that marly boulder clay, like that seen inland at Weybourne, and elsewhere, overlies the marine sands on the Cromer coast (near West Runton). At a pit a small distance inland at East Runton, the implementiferous gravel rests on North Sea Drift, and is covered in places by marly boulder clay.

It should be pointed out that, as the marine horizon, together with its contained implements, underlies the Chalky-Kimmeridgic Boulder Clay, it must be considerably older than, and probably represents the interglacial period preceding, that in which the well-known Middle to Late Acheulean, and Clactonian III deposits of Hoxne, High Lodge, Whitlingham, and Derby Road, Ipswich, were laid down.

The flake industry found at Corton, and in the Cromer area, may perhaps be described as representing, in a primitive form, the later well-made Clactonian III implements of the High Lodge brickearth. The "Cortonian" implements comprise side-scrapers (an outstanding form with the bulb of percussion at the side), hollow-scrapers (very rare), square-ended scrapers, and some small examples of the ordinary round-ended variety. Points are by no means common. The flakes exhibit flat striking-platforms, and have been, in many cases, modified by secondary flaking into knives and other forms. The great majority of the specimens exhibit a certain amount of gloss, but are otherwise not patinated. The flint is black, usually with a thin cortex. The artefacts exhibit very little sign of rolling by water action, and scratches on the flaked surfaces are very seldom present.

It is possible that the industry represented may be of early Acheulean date; but, with the exception of one specimen of a partly finished hand-axe, the forms of the implements do not, in the present state of our knowledge, support this supposition. A detailed paper on this research will be published in due course.

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J. REID MOIR.
D. F. W. BADEN-POWELL.

Estimation of Uronic Anhydride Residues in Polysaccharides

IN the course of work on the constitution of certain wood starches and other polysaccharides containing uronic acid residues, we have found it necessary to investigate more closely the accuracy of the analytical methods used in the estimation of the uronic acid content. The usual procedure consists in heating the substance with aqueous hydrochloric acid and measuring the amount of carbon dioxide liberated.

Preliminary experiments revealed that potato starch gave an appreciable amount of carbon dioxide, and further investigation showed that the explanation of this lies in the fact that glucose and maltose give carbon dioxide under these conditions, the yield (*c.* 0·5 per cent) being similar to that observed with starch. It will be seen from the accompanying table that a similar yield of carbon dioxide is given by several types of starch and by cellulose, and the conclusion is reached that none of these polysaccharides contains any uronic acid residue. Fructose and fructose polysaccharides (for example, inulin) also give carbon dioxide when heated with hydrochloric acid, and, as might now be expected, so does sucrose. Rhamnose gave rather higher values, but a typical methylated sugar (2 : 3 : 6-trimethyl glucose) gave a smaller yield of carbon dioxide, presumably owing to the greater stability of the methyl ether groups; and mannitol, which cannot give rise to a reducing sugar, gave no carbon dioxide. In the case of glucose,

fructose and sucrose, similar behaviour has recently been observed by H. Colin and Mlle. S. Lemoyne[1].

Percentage of Carbon Dioxide evolved from Carbohydrates.

Substance	CO_2	Substance	CO_2
Potato Starch	0·30	Galactose	0·46
Rice Starch	0·45	Fructose	0·55
Wheat Starch	0·40	Inulin	0·60
Horse Chestnut Starch ..	0·50	Sucrose	0·52
Cellulose	0·17	Xylose	0·40
Glucose	0·40	Arabinose	0·47
Maltose	0·40	Rhamnose	0·90
2 : 3 : 6-Trimethyl glucose	0·20	Mannitol	0·00
Mannose	0·55		

It will be apparent that these results are of special importance in the investigation of polysaccharides. In connexion with starches, no structural significance can be attached to reported carbon dioxide yields of the order 0·3–0·5 per cent, whilst for certain other polysaccharides, yields of carbon dioxide up to 1 per cent may be equally unreliable as an index of the presence of uronic anhydride. These observations do not, however, affect the claim previously advanced by one of us[2] that certain wood starch preparations contain uronic anhydride, except in so far as the numerical value of the results is concerned. The present experiments were carried out in an atmosphere of nitrogen in an improved form, evolved by one of us (W. G. C.), of the apparatus described by Dickson *et al.*[3] With this, consistent blanks were obtained corresponding to less than 0·2 per cent carbon dioxide under the conditions of the above analyses. A scrubber containing aniline was used to absorb furfural liberated from pentose residues. Otherwise furfural may be carried over to the barium hydroxide solution, with vitiation of the results.

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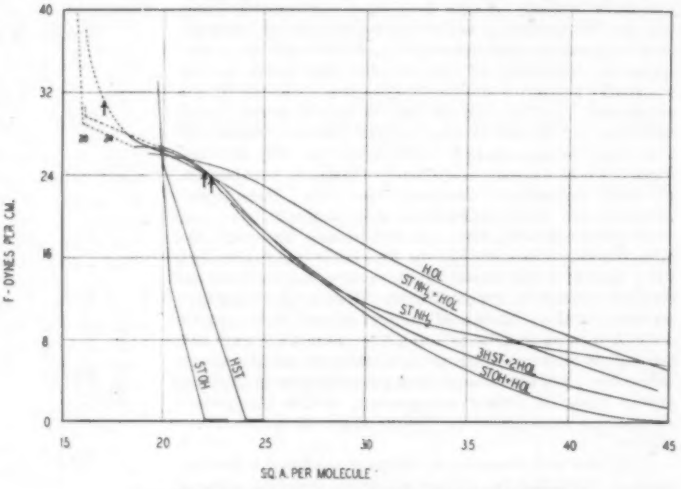
[1] Colin, H., and Lemoyne, S., *Bull. Soc. Chim. biol.*, **20**, 343 (1938).
[2] Campbell, W. G., *Biochem. J.*, **29**, 1068 (1935).
[3] Dickson, A. D., Otterson, H., and Link, K. P., *J. Amer. Chem. Soc.*, **52**, 775 (1930).

Effect of Space Isomerism on the Squeezing out of an Unsaturated Compound from a Mixed Monolayer on an Aqueous Sub-solution

As the pressure is increased on a mixed film produced by a 1 : 1 mixture of oleic acid (HOL) with stearyl alcohol (STOH) or amine, or stearic acid (HST), the unsaturated oleic acid begins to separate out at about 24 dynes per cm., at which pressure minute particles of the oleic acid become visible in the dark field microscope used for observation. Practically all the oleic acid is squeezed out if the area is sufficiently reduced, and the pressure-area relations become those found for a pure film of stearic acid or stearyl alcohol on the same subsolution (Fig. 1).

While Schulman has indicated that this is probably due to a lessening of the attraction between the hydrocarbon chains by the presence of the double bond, earlier work by Harkins indicates that the double bond does not lessen this type of attraction. It seemed to us that the phenomenon has its origin rather in the space relations. The carboxyl or hydroxyl groups of all these compounds have about the same attractive energy toward the water of the subphase. That it is the oleic acid which is squeezed out is apparently due to the fact that the bending of the chain by the double bond causes the molecule in its rotation about an axis perpendicular to the surface of the water, and in its vibrations and flagellations, to sweep out a larger area than the saturated molecules. This increased area causes it to be less firmly bound in the film.



Oleic acid, HOL Stearyl alcohol, STOH
Stearic acid, HST Stearyl amine, $STNH_2$

It is usually supposed that oleic is a *cis*-, and elaidic acid is the corresponding *trans*-form. If this be true, it seems apparent that elaidic acid would sweep out a smaller molecular area, and would be, therefore, much more tightly bound in the mixture. This proved to be the fact, since while the ultramicroscope shows that some elaidic acid may be squeezed out, the process is by no means complete as in the case of oleic acid. In fact, the amount which separates is very small, since the form of the pressure-area curves is not appreciably influenced thereby.

The above relations were found on an acid subsolution, but a change to a basic subphase (*p*H 9·5), while it altered the form of the curves, gave similar relations, and this was also true when calcium ions were present.

At *p*H 3 the presence of elaidic acid greatly condenses the expanded film of stearyl amine ($STNH_2$), while above a pressure of 8 dynes per cm. oleic acid expands it even above the areas of the expanded amine. By itself, however, elaidic acid as well as oleic, gives an expanded film. At the lower pressures, oleic acid gives much the higher molecular areas when pure, but the smaller compressibility of the

film of elaidic acid causes it to have higher areas at the higher pressures, that is, above about 15·5 dynes per cm. In the work represented by Fig. 1, the *p*H was 3, and the temperature close to 25°.

Note added October 20. In a paper which appeared after our letter was sent to NATURE, Marsden and Rideal (*J. Chem. Soc.*, 1938, 1193) also explain differences in behaviour between *cis*- and *trans*-unsaturated compounds as due to differences in the form of the molecules. Their theory of the effect is the more static, and ours the more kinetic.

A comparison of the experimental results is of interest, since their most convincing evidence is given by two single-component films in which the area is much greater per molecule for the *cis*- than for the *trans*-compound. Thus a 22-carbon atom molecule is long enough to give a sufficiently large van der Waals energy between *trans*-chains of brassidic acid to produce a condensed film, while with the corresponding *cis*-chain of erucic acid, the bend in the molecules prevents such a close approach so the film is expanded. In the case of the 18 carbon atom chains used by us, the shortening of the chain reduces the van der Waals energy sufficiently to prevent the formation of a condensed film by the *trans*-compound, so the difference between the *cis*- and *trans*-compounds, while marked, is not so great.

In contrast with this, the differences between *cis*- and *trans*-compounds given by their mixtures are very small, while some of those investigated by us exhibit extremely great effects. Thus in the mixtures on basic sub-solutions of stearyl amine with elaidic acid (*trans*) or oleic acid (*cis*), the isomeric forms not only give extremely great deviations from the mean behaviour, but also the *cis*-compound expands the area above that of either component, while the *trans*-compound condenses it below that of either component.

Thus the two researches, when considered together, present remarkably strong evidence for the general point of view expressed by Marsden and Rideal and by us, that it is the bend in the hydrocarbon chain at the double bond of *cis*-compounds which causes them to be less firmly bound to the other molecules of the film than is the case with *trans*-compounds, in which the bend is much less pronounced.

For the exhibition of these differences, space models should be used. These make it obvious that the effects are highly dependent upon the position of the double bond in the chain.

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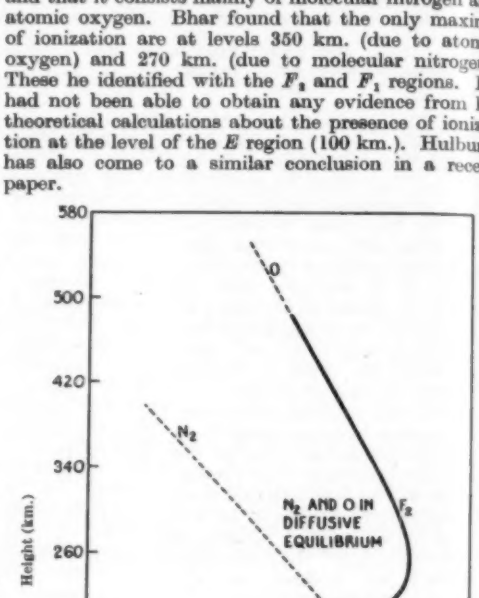
Aug. 14.

Origin of the *E* Layer of the Ionosphere

CHAPMAN'S hypothesis regarding the different origins of the *F* and *E* regions of the ionosphere, first put forward in his Bakerian Lecture[1] of 1931, is well-known. The *F* layer he attributed to the action of the ultra-violet rays of the sun and the *E* layer to the action of neutral solar corpuscles. The reason for his assuming two different agencies was that he was unable to obtain any evidence of ionization maximum below 200 km. by applying Pannekoek's theory[2] of upper atmosphere ionization based on Woltjer's extension of Saha's theory of thermal ionization. The question of the possible mode of formation of ionization maxima in the upper atmosphere has recently been re-examined by Bhar[3] with the help of Pannekoek's method on the recent view that the atmosphere above 100 km. has a high temperature and that it consists mainly of molecular nitrogen and atomic oxygen. Bhar found that the only maxima of ionization are at levels 350 km. (due to atomic oxygen) and 270 km. (due to molecular nitrogen). These he identified with the F_2 and F_1 regions. He had not been able to obtain any evidence from his theoretical calculations about the presence of ionization at the level of the *E* region (100 km.). Hulburt[4] has also come to a similar conclusion in a recent paper.



It is the purpose of this communication to discuss certain points regarding the possible mode of formation of the *E* region in the light of the results obtained by the above workers. Since considerations of ultra-violet absorption by oxygen molecules suggest the possibility of the *E* layer being associated with the photo-ionization of this gas[5], it would seem that the curious results obtained by these authors, namely, no evidence of ionization below 200 km., is to be attributed to the distribution of oxygen molecules in the high atmosphere assumed by them. Bhar, as mentioned above, assumes the atmosphere above 100 km. to be devoid of oxygen molecules—all of them having been converted to atomic oxygen by photo-electric dissociation. He therefore does not consider at all the ionization of molecular oxygen. Hulburt, though he assumes the presence of molecular oxygen (and molecular nitrogen) above 100 km., gets the result as stated above.

In view of the fact that recent investigations, both spectroscopic and theoretical, appear to show that the atmosphere above 100 km. is very poor in molecular oxygen, Bhar's assumption seems to be correct. It may be shown[6] that the dissociation of O_2 to O is practically complete at about the 130 km. level, and that the region in which the transition of the atmospheric composition (from N_2 and O_2 to N_2 and O) occurs is a fairly sharp one. It is therefore evident that in investigating the upper atmospheric ionization the photo-ionization of molecular oxygen in the transition region below 130 km. should be taken into account, particularly because the ionization potential of O_2 (16·5 ev.), being much different from those of O and N_2, this gas will produce its own level of maximum ionization. J. N. Bhar working in my laboratory has recently carried out the calculation of the photo-ionization of O_2 after Pannekoek's theory in the region of transition of O_2 to O. The result obtained by him and the assumptions on which his calculations are based are given below.

The region of transition ($O_2 \rightarrow O + O$) is taken to lie between 80 km. and 130 km. The density of molecular oxygen at the 80 km. level is known to a fair degree of approximation from radio and other meteorological considerations. This is taken[7] as $1{\cdot}6 \times 10^{14}$ molecules/c.c.; at 130 km. the density is assumed to be 10^4 molecules/c.c. Results of Bhar's calculations are depicted in the accompanying graph. For completeness, the ionization distributions for the F_1 and F_2 regions as obtained by him from revised calculations are also given. It is to be noted that the maximum of ionization in the transition layer occurs at the level of the *E* region, and that the ionized layer is extremely thin, which is in conformity with recent experimental evidence. The definite assertion can thus be made that the region around 100 km. in which rapid transition of O_2 to O occurs is also, as a consequence, the region of maximum ionization of O_2, and that the ionized layer formed near this level is to be identified with the *E* layer.

For carrying out the above calculations, a knowledge of the absorption coefficient of the gases under consideration is necessary. For atomic oxygen the value deduced recently by Saha and Rai[8] from wave-mechanical considerations has been used. For molecular oxygen and nitrogen, Bhar, in common with all previous workers, has utilized the well-known Kramers' formula for X-ray absorption with certain modifications. The use of this formula for neutral atoms and particularly for neutral molecules is open to serious objection[8,9]. Crude as this procedure is, the importance of the analysis still remains, for, if at any future date accurate experimental or theoretical values of the absorption coefficients and their variations with frequency be available, these need only be substituted in the working formula to get a more accurate result.

The origin of the *E* layer as explained above is due to strong absorption resulting in photo-ionization of molecular oxygen commencing at λ 744 A. There is, however, absorption due to nitrogen molecules and to oxygen atoms in this range of wave-lengths. The effect of this absorption will be to reduce the intensity of the wave-lengths necessary for the photo-ionization of molecular oxygen. This fact has been taken into account by taking the intensity of the radiation in this range as one-thousandth of what it would have been in the absence of the superincumbent gases.

A fuller and more detailed account of the investigation will shortly appear in the *Indian Journal of Physics*.

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[1] Chapman, *Proc. Roy. Soc.*, A, **132**, 353 (1931).
[2] Pannekoek, *Proc. Amsterdam Acad.*, **29**, 1165 (1926).
[3] Bhar, Paper No. 58, Mathematics and Physics Section, Indian Science Congress (January 1938).
[4] Hulburt, *Phys. Rev.*, **53**, 344 (1938).
[5] Saha, *Proc. Roy. Soc.*, A, **160**, 155 (1937).
[6] Majumdar, *Ind. J. Phys.*, **21**, 75 (1938).
[7] Ghosh, M.Sc. Thesis (1938), Calcutta University; see also Martyn and Pulley, *Proc. Roy. Soc.*, A, **154**, 455 (1936).
[8] Saha and Rai, *Proc. Nat. Inst. Sci. Ind.*, **4**, 319 (1938).
[9] Page, NATURE, **141**, 1137 (1938).

Effect of Temperature on the Intensity of X-Ray Reflection

WE have studied with a fibre camera, used in conjunction, and simultaneously, with a flat plate powder camera, the effect of temperature on the intensity of reflection of X-rays from copper. The effect has been examined over a range of temperature extending from room temperature to about 570° C.

According to Debye's theory as modified by Waller, in order to account for the decrease of X-ray reflection from a cubic crystal as the temperature is raised, the *intensities* of the interference maxima should be multiplied by a temperature factor exp. $(-2M)$, where $M = \frac{6h^2}{mk\Theta}\left(\frac{\varphi(x)}{x} + \frac{1}{4}\right)\cdot\frac{\sin^2\theta}{\lambda^2}$, m is the mass of the atom concerned, Θ is its characteristic temperature, $x = \Theta/T$ where T is the absolute temperature and $\varphi(x)$ is a certain function of x which Debye evaluates.

Observations made on the intensities of reflection from rock salt and sylvine by James and his collaborators show that the results obtained with these materials agree fairly closely with Waller's modification for temperatures ranging from 85° A. to 400° A., but that for higher temperatures up to about 900° A. there is a definite departure from the Debye-Waller formula, the intensity falling off more rapidly with rise of temperature than is allowed for by the formula.

The present results obtained with copper, which possesses face-centred cubic structure, show that *throughout* the range of temperature from 290° A. to 840° A., the decline of intensity with increase of temperature is greater than that predicted by the Debye-Waller formula. The experimental results agree closely with the calculated results if the temperature factor is assumed to be exp. $(-3M)$ instead of exp. $(-2M)$.

A full account of the investigation will shortly be published.

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Oct. 22.

A Lower Limit to Energy Evolution in Stellar Matter

It is well recognized that the energy generation in stellar interiors is due to nuclear reactions in which protons play a dominant part. This circumstance fixes, as is shown here, for stellar material of given density and chemical constitution a lower limit to the rate of energy-generation—the limiting value increasing very rapidly as the density of the material and the proportion of hydrogen in it increases. In the present note we shall only consider the reaction leading to the formation of deuteron by proton combination ($H + H = D + \varepsilon^+$), though the results discussed here can easily be extended to other nuclear transformations brought about by protons. The probability of this astrophysically important reaction has been recently calculated by Bethe and Critchfield[1], who conclude that for stars lighter than the sun this process is the main source of energy.

The existence of the lower limit mentioned above for the rate of energy-generation follows at once when we note that the probability of the nuclear reaction is a function of the velocity of the protons, and as the protons obey Fermi-Dirac statistics, there exists for a given value of the proton-concentration (number of protons per unit volume) a '*minimum* energy distribution'—the distribution corresponding to a *completely* degenerate gas. Therefore, the limiting value of the energy-generation for a given proton-concentration n is obtained by averaging the probability of reaction for a velocity-distribution corresponding to that of a *completely degenerate proton gas*, that is, the limiting value gives the energy-generation when, for a fixed n, the temperature $T \to 0$.

If ε_0 denotes the minimum rate of energy-generation per *gram* of the material, then, following Bethe and Critchfield, with necessary alterations to take account of the new velocity-distribution law, we finally obtain

$$\varepsilon_0 = 2{\cdot}4 \times 10^{3}\ \rho c_H^{\,2}\ e^{-z}$$

where ρ is the density of the material, c_H the proportion of hydrogen by weight, and z is given by

$$z = 4\pi^2\left(\frac{\pi}{3}\right)^{1/3} \frac{m_H e^2}{h^2 n^{1/3}} = 4{\cdot}2 \times 10^{3}\ \frac{1}{(\rho c_H)^{1/3}},$$

where m_H is the mass of the hydrogen atom, e the electron-charge and h is Planck's constant.

In the following table the values of ε_0 are given for different densities for the case of $c_H = 1$ (all hydrogen) and $c_H = 0{\cdot}3$ (30 per cent hydrogen).

Minimum energy evolution for different densities and hydrogen concentration

Density (gm./cm.³)	10^4	5×10^4	10^7	5×10^7
ε_0 for $c_H = 1$, (erg/gm.sec.)	$1{\cdot}4 \times 10^{-9}$	0·26	82	$1{\cdot}3 \times 10^{5}$
ε_0 for $c_H = 0{\cdot}3$, (erg/gm.sec.)	$1{\cdot}2 \times 10^{-19}$	$1{\cdot}3 \times 10^{-7}$	$4{\cdot}9 \times 10^{-4}$	$4{\cdot}3 \times 10^{2}$

It will be seen that ε_0 varies extremely rapidly with ρ and c_H. In the case of degenerate proton gas, the rate of energy-generation for a given ρ and c_H will not differ much from the value corresponding to *complete* degeneracy, but for non-degeneracy it will obviously be widely different.

The existence of a lower limit to the rate of stellar energy-evolution is particularly significant in connexion with the white dwarf stars (and also nuclei of planetary nebulæ). These applications, however, will be discussed elsewhere.

D. S. Kothari.

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Oct. 6.

[1] Bethe and Critchfield, *Phys. Rev.*, **54**, 248 (1938).

Seismic Methods in Submarine Geology

Prof. Maurice Ewing has shown that it is possible to use the seismic method for investigating submarine geology, and has used the method to show that, in the continental shelf off the coast of Virginia, many thousands of feet of sediments overlie the Palæozoic or pre-Cambrian rocks.

The Royal Society recently appointed a Committee with Rear-Admiral Edgell, hydrographer of the Navy, as chairman, to organize similar measurements on the eastern side of the Atlantic. The Lords Commissioners of the Admiralty made H.M. surveying ship *Jason* available for the purpose, and she was anchored successively at five stations on a line extending 170 miles west-south-west from the Lizard, and at each station geophones were lowered to the sea bottom. The geophones were connected to recording apparatus in the ship and records were made of the ground motion produced by the explosion of charges of up to 62 lb. of T.N.T. laid on the sea floor and fired from a motor-boat.

Forty-six records, mostly of satisfactory quality, were obtained, and time-distance curves were constructed. The first station was four miles south of the Lizard; the velocity of elastic waves in the surface rocks was 11,000 ft./sec.; this is too fast for recent sediments, but too slow for the igneous rocks of the Lizard. This surface layer was found to be 1,000 ft. thick and to be underlain by rocks in which the explosion wave travels with a velocity of 23,000 ft./sec.; the latter are presumably the igneous rocks. The occurrence of the 11,000 ft./sec. layer on top of the igneous rock is of considerable interest, and there is reason to believe from the results of dredging, that it represents an outlier of Trias, and indicates that the Channel was formed along the line of a pre-existing basin.

The next two stations are sixty and eighty miles west-south-west of the Lizard, and they showed 550 ft. and 1,000 ft. of sediments with a transmission velocity of 6,000–7,000 ft./sec. At the two outer stations (115 and 170 miles west-south-west of the Lizard), only lower limits can be set to the thickness of the sediments, as bad weather prevented very long lines from being shot. At the outermost of these stations the records are of excellent quality and show that there is certainly no rock having high transmission velocity similar to that found at the other three stations within 4,000 ft. of the surface. The next station shows that there are not less than 2,000 ft. of sediments.

It has been established, therefore, that a substantial part of the continental shelf is composed of relatively unconsolidated rocks. Measurements of the velocities of elastic waves in the rocks of Cornwall and Devon are to be made in the near future.

This preliminary note is published with the permission of the Royal Society. In a later more detailed account, it will be possible to make proper acknowledgments to those who have assisted in the measurements and in the preliminary work.

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Sept. 27.

Oxygen Isotopic Exchange in Animal Respiration

Oxygen enriched with respect to ^{18}O has been used to solve the problem of how far oxygen, expired by an animal in the form of carbon dioxide, is identical with that inspired as molecular oxygen. Using rats, and an artificial atmosphere containing oxygen equivalent in isotopic composition to water of 300 p.p.m. excess density, it was found that the expired carbon dioxide, which was dried and collected by refrigeration methods, contained oxygen isotopes in proportions corresponding to water with about 40 p.p.m. excess density, the error of measurement being 2 p.p.m. As the quantity of oxygen absorbed by the animal during each preliminary sweep-out was considerably greater than the total oxygen and carbon dioxide stored as oxy-hæmoglobin or bicarbonate, it can be accepted that the experimental results refer to the steady state.

The two possibilities usually considered with regard to the fate of respiratory oxygen are: (1) it enters directly into carbon oxidation and is exhaled as carbon dioxide; (2) it enters into combination with the hydrogen of water, the originally combined oxygen of which effects carbon oxidation and appears as carbon dioxide. Our results show that mechanism (1) operates, since (2) acting alone would lead to an almost complete absence of inspired oxygen from the expired carbon dioxide. The fact that only a proportion of the inspired oxygen reappears may be due to oxygen exchange between water and carbon dioxide produced by mechanism (1); or it may be due to the incursion of mechanism (2).

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Nov. 1.

Induced Tetraploidy in *Melandrium album*

In the flowering plants, the problem of polyploidy in relation to dicœcism is an extraordinarily attractive one, since it should be possible in this way to get additional proof of the balance theory of sex determination.

So far, experimentally produced polyploids have not been described in dicœcious plants, but occasionally such forms have been found in Nature. In *Rumex*[1,2], triploids, tetraploids and a hexaploid have been described; in *Vallisneria*[3] and *Empetrum*[4], tetraploids are known to occur. These polyploids, which are considered by the authors to be of autopolyploid origin, are in *Rumex* intersexual, in *Empetrum* bisexual and in *Vallisneria* dicœcious, as in the diploid form.

In *Melandrium album*, dicœcism is very clear-cut. The male sex is heterogamous, having 11 pairs of autosomes and one pair of XY chromosomes, the X chromosome being considerably larger than the Y and larger than any of the autosomes. The female plants are homogamous, having 11 pairs of autosomes and 2 X chromosomes[5,6].

Tetraploids have been induced in *Melandrium album* in the summer of this year by the method of Randolph[7] as well as by the colchicine method[8]. The tetraploid plants differ little from the diploids in appearance, and are very difficult to pick out. Their leaves are somewhat thicker, the hairiness more conspicuous and the flowers relatively large. Only chromosome counts can tell us the true nature of the suspected plants, and so far ten plants (out of 1,700) have proved to be tetraploid.

These tetraploids are interesting from several points of view. First concerning the sex expression. The tetraploid plants show a dicœcism just as clear-cut as that of the diploids; the $XXXX$ plants are females, the $XXYY$ plants are males (six of the ten tetraploids were males, four were females). Secondly, concerning the meiosis in tetraploid males, a preliminary investigation has shown that the most frequent conjugation type of the sex chromosomes is autosyndesis, that is, X—X and Y—Y chromosomes pair. Less frequently the sex chromosomes conjugate X—Y and X—Y. The first mode of conjugation will give rise to gametes containing two sets of autosomes ($2A$) an X- and a Y-chromosome ($2A+X+Y$). The second mode will produce gametes of three sorts: ($2A+2X$), ($2A+X+Y$) and ($2A+2Y$) in the theoretical ratio 1 : 4 : 1, as previously postulated by H. J. Muller[9]. A considerable excess of gametes of the formula ($2A+X+Y$) will result. As the females by normal chromosome separation will produce egg-cells of the type ($2A+2X$) only, three types of plants should appear by breeding tetraploids with tetraploids, if all types of gametes are viable, the plants being of the formulæ ($4A+4X$), ($4A+2X+2Y$) and ($4A+3X+Y$). It may further be mentioned that it is possible to cross tetraploids with diploids, both in the direction tetraploid female × diploid male, and the opposite way. This should give rise to three types of triploids, containing the chromosome sets ($3A+3X$), ($3A+2X+Y$) and ($3A+X+2Y$). Thus the polyploid *Melandrium* should furnish very promising material for the study of sex balance.

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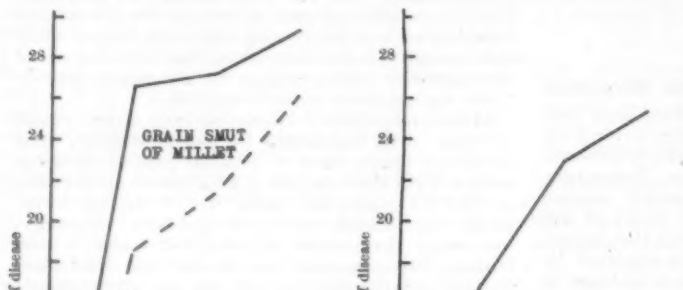
[1] Ono, T., and Shimotomai, N., *Bot. Mag.*, **42**, 269 (1928).
[2] Yamamoto, Y., *Jap. J. Gen.*, **11**, 6 (1935).
[3] Jørgensen, C. A., *J. Gen.*, **18**, 63 (1927).
[4] Hagerup, O., *Dansk bot. Arkiv*, **5**, 1 (1927).
[5] Blackburn, K. B., Nature, **112**, 687 (1923).
[6] Winge, Ø., *C.R. Trav. Lab. Carlsberg*, **11**, 1 (1923).
[7] Randolph, L. F., *Proc. Nat. Acad. Sci.*, **18**, 222 (1932).
[8] Blakeslee, A. F., and Avery, A. G., *J. Heredity*, **28**, 393 (1937).
[9] Muller, H. J., *Amer. Nat.*, **59**, 346 (1925).

Control of Four Smut Diseases by Regulation of Planting Method under Irrigation

Anomalous amounts of disease in supposedly exactly repeated experiments of flag smut of wheat, and previously with covered smut of barley[1], were eventually traced to difference in planting method. Under irrigation in Egypt, these cereals are either broadcast on moist land and ploughed in (*herati* method) or broadcast on dry land, harrowed in with a wooden baulk and irrigated (*afir* method).

Direct experiment proved two to three times more flag smut in *herati* plantings and similarly for covered smut of barley (six times), bunt of wheat (five times) and grain smut of millet. Analysis indicates two factors operating, depth of sowing and soil moisture, shown in the accompanying graphs, where all differences are highly significant.



Full lines, moist soil (*herati*).
Broken lines, wet soil (*afir*).

Increase with depth has been recorded for flag smut[1], and again not only with covered smut but also with loose smut of barley[2], a flower infecting smut unlikely to be thus influenced; but perhaps this 'loose smut' was caused by the then unrecognized *Ustilago nigra*, a seedling infection.

The cause of progressive increase may be the longer susceptible stage of deeper planted seedlings, while the strikingly small disease in the shallowest sowings may be due to coleoptiles growing more in air than damp soil. The sudden effect in millet is perhaps related to the rapidly growing mesocotyl lifting the primary bud above the soil.

The soil moisture factor is consistent and smaller, but increases with depth. It is frequently mentioned in the literature (though few have worked with the very high soil moistures common under irrigation) and is usually ascribed to poor aeration. The abnormally large effect in flag smut may be partly due to the peculiar germination needs of the spores[4] on the seed and in the soil, and hence partly dependent on the moisture history before sowing.

While these results must generally remain only of scientific interest, they become immediately important in irrigation farming, where both operating factors are controllable. The greatest inhibition of disease could be achieved if seed were broadcast on the surface of sodden soil, where fine particles allow soil moisture to reach the absolute maximum. The results of two adjacent experiments with this new 'mud sowing' method are shown in the table below.

Mud sowing seems worth thorough testing for agricultural value, apart from disease insurance. It gives early tillering, which may account for the improved size and maturity of grain obtained by Method 1. There is an indication of higher yield (although the elimination of 8 per cent of flag smut is unlikely to be the reason in Egypt) and seed rate might be reduced.

Thus in irrigation countries special planting methods may present a practicable alternative to seed disinfection or immune varieties in preventing smut diseases.

A full account of this and related subjects will be published as a *Scientific Bulletin* of the Egyptian Ministry of Agriculture.

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Sept. 17.

[1] Jones, G. Howard, *Bull. Min. Agric., Cairo*, No. 142, 13 (1934).
[2] Miller, W. B., and Millikan, C. R., *J. Dept. Agric., Victoria*, **33**, 365 (1934).
[3] Taylor, J. W., and Zehner, M. G., *J. Amer. Soc. Agron.*, **23**, 132 (1931).
[4] Noble, R. J., *Phytopath.*, **13**, 127 (March 1923).

Planting method	Cultural operations	Resultant depth of sowing	Soil condition	Per cent flag smut	
				Exp. 1	Exp. 2
Herati	Seed broadcast on moist soil and ploughed in	About 8 cm.	Moist	8·1	8·6
Afir (usual)	Seed broadcast on dry soil, harrowed in with a baulk and irrigated	4 cm.	Wet		3·2
Afir (modified)	Seed broadcast on dry soil, covered by raking, and irrigated	2·5 cm.	Wet	2·4	
Mud sowing (Method 1)	Moist soil ploughed and flooded: seed broadcast on surface 1 hour later	Nil	Sodden	0·2	
Mud sowing (Method 2)	Dry soil flooded: seed broadcast on surface 1 hour later	Nil	Sodden		0·08

Bright Nebulosity in the 'Coalsack'

A programme on the dark patch in the Milky Way, known as the 'Coalsack', taken when at the Boyden Station of the Harvard Observatory, Bloemfontein, included a number of red plates on that region. On one of these, a three-hour exposure taken with the Bruce telescope with an Eastman *I–C* Special plate and Ciné red filter, a small patch of bright nebulosity was observed within the region of the 'Coalsack'.

Dr. Bok has confirmed for me the existence of this nebulosity on a long-exposure blue Bruce plate in the Harvard collection. There is no suspicion of nebulosity on two-hour exposure plates, but a six-hour exposure plate leaves no doubt of the reality of the nebula.

A detailed investigation will be published later.

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Oct. 19.

Mechanism of the Primary Photodissociation Processes of Organic Molecules

In his comments on our communication[1] under this title, Prof. R. G. W. Norrish[2] has raised certain questions which we naturally would like to answer. But as this discussion would certainly require more space than Nature can devote to these questions, we prefer to deal with the matter in the detailed paper which is now in course of completion.

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[1] Nature, **141**, 832 (1938).
[2] Nature, **141**, 1138 (1938).

Points from Foregoing Letters

Palæolithic implements belonging to a hitherto unrecognized type, apparently of early Acheulean date, have been found by J. Reid Moir and D. F. W. Baden-Powell near Cromer, in the marine sands at Corton, classified as 'Middle Glacial'. The implements are of black flint, usually with a thin cortex and mostly exhibiting a certain amount of gloss. Scrapers (side-, hollow-, square-ended and round-ended) and flakes modified by secondary flaking into knives, are among the implements found.

The liberation of small amounts of carbon dioxide from cellulose and from certain starches by aqueous hydrochloric acid has been shown by W. G. Campbell, Prof. E. L. Hirst, and G. T. Young to be due to decomposition of their constituent hexoses, and not to the presence of uronic anhydride residues. The yield of carbon dioxide from a number of typical carbohydrates is reported. Mannitol, which contains no potential aldehydic group, gives no carbon dioxide. These results do not vitiate the claim by W. G. Campbell that certain wood starch preparations contain uronic anhydride residues.

Prof. W. D. Harkins and R. T. Florence find that on compressing surface films containing oleic acid and stearic acid (or some other straight chain saturated compounds) the oleic acid separates out in the form of ultramicroscopic droplets due, the authors consider, to the fact that the bending of the chain at the double bond causes the molecule to require a greater surface and is consequently less firmly bound. Elaidic acid shows the phenomenon to a lesser extent and these findings together with those recently reported by Rideal and Marsden indicate also that the bend at the double bond causes the *cis*-compounds to be less firmly bound to the other molecules in the film than is the case with *trans*-compounds.

Prof. S. K. Mitra discusses some of the new work on the ionization of the upper atmosphere and suggests that the *E* layer (80–120 km. high) is a region of transition from molecular to atomic oxygen, and its ionization is due to photo-ionization of molecular oxygen by absorption commencing at a wave-length of 744 A.

The effect of temperature on the intensity of reflection of X-rays from copper (which possesses a face-centred cubic structure) shows, according to Prof. E. A. Owen and R. W. Williams, that throughout the range 290–840° Abs., the decline in intensity with increase in temperature is greater than that predicted by the Debye-Waller formula.

Dr. D. S. Kothari calculates the minimum energy evolved at different hydrogen concentrations by the combination of two protons to form a deuteron, which reaction is considered by Bethe and Critchfield to be the main source of energy for stars lighter than the sun. The minimum energy is obtained by averaging the probability of reaction for a velocity distribution corresponding to that of a completely degenerate proton gas.

Records of elastic ground waves produced by the explosion of charges of T.N.T. laid on the sea-floor and fired from a motor-boat indicate, according to Dr. E. C. Bullard and T. F. Gaskell, that off the coast of the Lizard a surface layer 1,000 ft. thick, in which the velocity of the elastic waves is 11,000 ft./sec., is underlain by rocks (probably igneous) in which the velocity is 23,000 ft./sec.

Experiments by Dr. J. N. E. Day and P. Sheel, in which rats were allowed to inspire oxygen containing the heavier isotope of mass eighteen and the expired carbon dioxide afterwards analysed for the heavier isotope, indicate that the inspired oxygen mainly enters directly into carbon oxidation and is exhaled as carbon dioxide.

M. Westergaard reports that tetraploids induced in *Melandrium album* by the method of Randolph and by colchicine treatment differ little from diploid plants in appearance. They show the same clear-cut diœcism. The most frequent conjugation type of the sex chromosomes in tetraploid males is auto-syndesis.

G. Howard Jones and Seif el Nasr have discovered that the amount of four cereal smut diseases in Egypt differs greatly according to the method of planting. They have analysed this effect into a large factor of depth of sowing and a smaller factor of soil moisture. They have thence developed a 'mud sowing' method of sowing seed on the surface of soaked soil, which is practicable under irrigation, and almost eliminates disease.

Research Items

Skeletal Remains from Kansas Mounds

Human skeletal remains with crania of a distinctive type have been discovered in mounds near Kansas City excavated by Dr. Walso R. Wedel of the Smithsonian Institution, Washington. In a preliminary report issued by the Institution, the skulls are described as distinguished by a ridge in the centre of the frontal bone, which must in life have given the people the appearance of having obliquely arched foreheads. The mounds in which these remains were found were low, never more than five feet high, each of them enclosing a partly subterranean rectangular stone chamber. Some of the remains had been cremated. The people were American Indians, but possibly of considerable antiquity. These 'houses of the dead' at one time had been numerous, but a large number had been destroyed or looted within the last seventy-five years, so that few were found in good order. To date eight complete or reconstructable skulls have been obtained. It is thought possible that the mounds are to be associated in some way with the Mound Builders of the Ohio Valley, the so-called Hopewellians. In the suburbs of Kansas City, artefacts have been discovered, which unquestionably belong to the general Mound Builder complex, and representing the most westerly extension of that culture known at present. Although the long-headed Kansas skulls might be related to the Mound Builders, no artefacts assignable to that culture have been found in the tombs. It is possible that the stone burial chambers may represent an early manifestation of the Hopewellian culture, or a variation adopted in a treeless region. The practice of the Hopewellians was to place their dead in a log house and when it was filled to set it on fire and pile earth over the ruins, making a mound about fifteen feet high. Sometimes two of these houses were set close together and eventually formed one mound. Owing to this practice of cremation, it is difficult to obtain a view of the physical type from such material as escaped the flames. Hence the peculiar physical type of the Kansas remains does not bar them from association with the Hopewell people.

Relation of Rare Defects to Population Changes

The effects of inbreeding and isolation in a population on the frequency of occurrence of recessive or dominant characters due to single or multiple genes, is discussed by Dr. Gunnar Dahlberg (*Proc. Roy. Soc. Edinb.*, **58**, Part 2, No. 15). His conclusions are based on the statistics of cousin and other consanguineous marriages in Germany, France and Italy. He points out that any group within which marriages chiefly take place, owing to geographical or social barriers, can be regarded as an isolate in which amphimixis is occurring. Any particular recessive mutational genic defect will be unequally distributed in the population of a country, and the best way to decrease it is by decreasing the number of consanguineous marriages. But even the abolition of cousin marriages would only decrease the frequency of the carriers of rare genes by 10–15 per cent. Increasing the size of isolates, through increasing communications or through population growth, diminishes the number of recessives. In Prussia, first cousin marriages decreased from 0·71 per cent in 1875 to 0·20 per cent in 1926, so that the frequency of inbreeding is one third what it was fifty years ago, while the number of marriages has nearly doubled. In Bavaria the changes are still more marked, while in France the total number of marriages has remained nearly constant, as well as the frequency of cousin marriages, which remains at about one per cent. Movement from country to town increases the size of town isolates, while increasing intercommunication increases the size of country isolates. Both these effects will diminish the frequency of rare recessive defects. In Prussia and Bavaria, where the size of the isolates has more than doubled in fifty years, the rare recessives will have decreased by at least one half.

Relation between Ovaries and Uterus during Pregnancy

The golden hamster, *Cricetus auratus*, is a comparatively new laboratory animal, having been introduced from Syria in 1932. It is now fairly widely distributed, for it is easily reared and managed under laboratory conditions. The length of pregnancy is only sixteen days, which is shorter than that of other laboratory rodents. M. Klein (*Proc. Roy. Soc.*, B, June 1938) has investigated in it the relation between the ovaries and uterus during pregnancy. Ovariectomy between the ninth and thirteenth days brings pregnancy to an end. Injection of progesterone and œstrone simultaneously into the ovariectomized hamsters maintained pregnancy in some instances up to parturition. The duration of the corpus luteum of pseudopregnancy is noticeably shorter than in true pregnancy. Complete removal of the uterus between the eighth and thirteenth day of pregnancy results in the rapid regression of the corpora lutea and the initiation of the ovarian cycle. The removal, by Cæsarean section, of the fœtuses only, leaving the placentæ inserted, does not shorten the duration of the corpora lutea or remove the inhibition of the ovarian cycle. No interpretation of the mechanism connecting the uterus to the ovary is suggested.

Experiments on Hæmostasis

A. Grassi (*Policlinico* (*Sez. Chr.*), **45**, 72; 1938) records his experiments on rabbits in which application of powdered bone to wounds of the liver had a remarkable hæmostatic effect, the hæmorrhage ceasing in 10–20 seconds. It was important that the powdered bone should have come from the same animal as that in which the liver was wounded, as the hæmostatic action of bone taken from another animal was much less. Grassi regards the hæmostasis as due mainly to a chemico-biological action of the powdered bone and only in a very small degree to its mechanical action.

Parasites of the Elephant

Taking advantage of his own examination of the internal parasites of four Indian and of several African elephants, O. P. van der Westhuysen has compiled a monograph of the helminth parasites of the two species (*Onderstepoort J. Vet. Sci. Anim. Industry*, **10**, 49; 1938). The parasites show a fairly

strict host specificity, no species having yet been found to occur in both African and Indian elephants, although both possess an extensive nematode fauna. Amongst the Strongylidæ, the African elephant has 25 parasitic species, the Indian 12; the Anchylostomidæ are represented by 3 species in the African, 4 in the Indian; the Syngamidæ has only one species—in the Indian elephant. In all, ten nematode genera are represented in this fauna and of these, four are confined to the Indian species—*Equinubria*, *Decrusia*, *Bathomostomum* and *Choniangium*. All the Strongylids are parasitic in the alimentary tract, except the members of the genus *Grammocephalus*, the adults of which inhabit the bile-ducts. The author gives descriptions of the species, keys for specific identification and many illustrations of distinguishing characters.

Botanical Research in Brazil

THE University of São Paulo, Brazil, proposes to publish the work of the different departments of the faculty of science separately, all correspondence to be addressed Caixa Postal, 2926, São Paulo, Brazil. The first botanical publication, *Botanica*, No. 1, 1937, contains several interesting papers by Prof. Felix Rawitscher on experiments upon factors controlling leaf symmetry and by his scientific assistant, Dr. Karl Arens, upon the photosynthetic process. Dr. Arens also has a description of the different modes of entry of the germ tubes of *Bremia Lactucae*. The germ tubes of the conidia enter nearly always by piercing the leaf cuticle just above the position of an anticlinal wall, the zoospores settle down near a stoma and the germ tubes penetrate through the stomatal aperture.

Features in Fern Prothalli

P. N. MEHRA is mainly concerned with the occurrence of apogamy in the prothalli of *Adiantum lunulatum* and *Pteris biaurita* in two papers recently published (*Proc. Indian Acad. Sci.*, **8**, B, No. 3); but considerable interest is also attached to the very fine photographs he gives of the typical, spirally thickened tracheids in the prothallus of *Adiantum*. He describes these as of regular occurrence and a specific character of this gametophyte, and a study of their development and detailed structure would have great interest as they would appear to be typically protoxylem elements though occurring in gametophyte tissue. In this connexion, it may, of course, have significance that they occur in a prothallial cushion on the anterior face of which may afterwards arise a fern sporophyte as a vegetative bud. None the less, these tracheids are said to be typical of the normal prothallus—apart from the apogamous formation of vegetative buds, and they are also said to have no direct continuity usually with the vascular strands of such buds when they arise. It is possibly also suggestive, in connexion with their presence, that Mr. Mehra sees a tendency in these prothalli to continue vegetative growth, even after the production of a sporophyte has commenced. The prothalli of *Adiantum* raised from spores from ferns from Sikkim showed no trace of archegonia, while others from spores collected at Kulu grown under the same conditions produced normal archegonia. The prothalli of *Pteris biaurita* developed neither archegonia nor the usual prothallial cushion. All these prothalli produced apogamous embryos; even in the Kulu prothalli of *Adiantum* the archegonia played no part in embryo formation.

Leaf-Spot of Bananas

A BULLETIN of the Department of Science and Agriculture, Jamaica (No. 15, New Series, Govt. Printing Office, 1938) describes the leaf spot disease of bananas caused by *Cercospora musæ*. Three types of infection are known, and the spots pass from yellow to brownish-black, having finally a grey centre. The disease has a seasonal recurrence, being most severe in the rainy season, when temperatures are low. It occurs most seriously on compact alluvial soils, on soils of white limestone origin, and on the badly eroded soils of ridges. Spasmodic, succulent growth favours the parasite more than the steady, riper growth associated with the older banana lands. These conditions of external environment have a strong influence upon the incidence of the fungus, but control can also be effected by spraying with Bordeaux mixture.

Horticultural Uses of Peat

DIMINISHING supplies of stable manure have made gardeners acutely aware of the need for maintaining sufficient organic matter in their soils. A very convenient source of humus is peat, and Mr. W. J. C. Lawrence briefly describes the various kinds in a short paper in the *Gardeners' Chronicle* of September 24. Wet peat can hold as much as 95 per cent of water, and is therefore useful for increasing the water-holding capacity of light soils. 'Rhododendron peat' usually has considerable quantities of silt and sand, and may have weed seeds in addition. Moss peat and sedge peat are of uniform texture, and are free from weeds. Mixtures of peat and artificial fertilizers provide adequate substitutes for farmyard manure, and peat is also useful as a constituent of rooting composts for cuttings. It often has, in addition, a *p*H of about 3·5, and this would help the growth of many garden crops which require an acid medium.

Soils of Dutch East Indies

IN an article entitled "Climate and Soil in the Netherlands Indies" (*Bull. Colonial Institute of Amsterdam*, 1, No. 4), Dr. E. C. J. Mohr directs attention to certain factors that affect the soil and so the productivity of the various Dutch islands of the Malay Archipelago. Rainfall differs much: in some islands it falls on almost every day in the year; in others there is a marked dry season of greater or shorter duration. Heavy rainfall causes leaching and impoverishment of the soil. Hence it is the areas with a dry season that are most fertile. Middle and East Java are more productive than Sumatra, in the same way that elsewhere in the world the civilized peoples of the tropics have always been in dry or comparatively dry regions. The higher the altitude the lower the temperature. This decreases the power of rain to leach the soil and so results in greater fertility at high elevations than on lowlands, always provided that, first, the high elevation does not mean a greatly increased rainfall and, secondly, steep gradients do not facilitate active soil erosion. Furthermore, higher elevations on account of lower temperature have more humus in the soil: this enhances their fertility. The one factor of great importance in restoring the fertility of the soil is the action of volcanoes that scatter ashes. These, when basic, help to restore the value of the soil; hence again the greater fertility of Java than Sumatra and the poor soils of Borneo and New Guinea.

Earthquakes in the Neighbourhood of Lake Michigan

This is an area where earthquakes are rare. Since 1804 there have only been seven of greater intensity than 5 on the Rossi–Forrel scale, namely 1804 Chicago (6), 1883 Kalamazoo (8), 1909 Freeport (8), 1912 Aurora (6), 1928 Mt. Carroll (5), 1934 Rock Island (6), and 1938 Porter (6). This last one has been studied by A. R. Schmitt, S.J., of Loyola University, Chicago, Illinois (*Earthquake Notes and Abstracts*, 10, Nos. 1 and 2, 19–21). The earthquake was recorded on February 12, 1938, shortly after midnight, by seismographs at the University of Chicago and at Loyola University, but not at the next further stations at Ann Arbor, Cincinnati and St. Louis. The *S–P* interval on the Wiechert record at Loyola was 9 seconds, the beginning of the *P* phase being at 6 h. 27 m. 41 s. G.M.T. whilst the Milne–Shaw at the University of Chicago registered *P* at 6 h. 27 m. 39 s. G.M.T. Joliat's tables thus give the epicentral distance from Loyola as 60 km. or 38 miles. In the absence of other instrumental evidence, the area was canvassed for human evidence, and this was greatly assisted by the *Chicago Tribune*. This established the presence of a sound concurrent with the shock, which many thought to be double, "like a heavy truck passing the house", and also established the epicentral point as being in the lowland approximately fifteen miles to the east of Porter, Indiana.

Earthquake Sounds

Although it is usual for a rumbling sound to accompany most earthquakes, this aspect of the shocks has not received a great deal of attention. Dr. C. Davison (*Bull. Seis. Soc. Amer.*, 28, No. 3; July 1938) helps to make good this deficiency by publishing the results of his large collection of observations chiefly from the British Isles. He draws thirteen conclusions, the chief of which are: (1) that the sound is a low rumbling one; (2) as the distance from the origin increases, the sound becomes smoother and more monotonous; (3) the intensity of the sound increases to a maximum with the strength of the shock and then dies away with it; (4) in British earthquakes, the sound area bears to the disturbed area a ratio that increases from an average of 54 per cent for earthquakes of intensity 8 to one of equality for earthquakes of intensity 4; (5) the duration of the sound is usually greater than that of the shock.

Copper Content of Sea Water

Since a number of marine organisms need comparatively large quantities of copper for their metabolism, for example, in the form of the blood pigment hæmocyanin, it is interesting to determine the concentration of copper in sea water from which these organisms must derive their supplies. In the expedition of the *Meteor* in the North Atlantic earlier this year, the copper content of water in the sub-tropical North Atlantic (Sargasso Sea) was determined by a photometric method. The results have recently been published by K. Kalle and H. Wattenberg (*Naturwiss.*, 26, 630; 1938). The concentration of copper obtained at ten different stations varied from less than 3γ per litre to 12γ per litre. At greater depths, values up to 30γ per litre were obtained; but it is possible that these results were spoilt by impurities arising from the dredges, and they therefore represent maximum values. The concentrations of copper found are too small to lend support to the theory that the colour of sea water is affected by its copper content.

Steroidal Hormones

In a paper summarizing thirty-nine previous communications, R. E. Marker (*J. Amer. Chem. Soc.*, 60, 1725; 1938) discusses the origin and interrelationship of the steroidal hormones from a general point of view. The isolation and synthesis of sex hormones and the isolation of steroids from the adrenal cortex have led to an increasing realization of the important part played by steroids in the animal. It seems to be generally assumed that these various steroids arise from cholesterol, but the author brings together several lines of evidence which make this seem improbable, and it is suggested that sex hormones and the cortical substance may be derived from another precursor. The steroidal hormones, including the C–18, C–19 and C–21 sex hormones, and the cortical steroids may come from a common precursor, pregnadiene-4,8-diol-17,21-trione-3,11,20, or its hydrate at C–9. The bile acids are also supposed not to originate from cholesterol. Consideration of the interrelationships among the many steroids make it possible to propose a definite structure for the precursor of the steroidal hormones, and it is shown how the various steroids isolated may arise from this precursor by orderly processes following definite rules and, with few exceptions, having their counterpart in laboratory reactions. The paper gives a useful review of some of the literature bearing on its subject.

Variability of the Sun's Radiation

An important contribution to the study of the variability of the sun's radiation has recently appeared (*Quart. J. Roy. Meteor. Soc.*, July 1938). It is an abstract of a thesis by Miss M. M. Paranjpe. Improved methods of measuring the radiation received from the sun at the earth's surface have been developed by Abbot at the Astrophysical Observatory of the Smithsonian Institute during the last thirty years, and with their aid very careful determinations of the solar radiation have been made on a number of mountains. Mountains were chosen to facilitate the difficult task of allowing for the selective absorption of different wave-lengths by the atmosphere before determining the solar constant. Errors of observation, and of computation of this absorption, result in apparent variations of the solar constant from day to day; but real variations, if large enough, would be revealed by positive correlation between simultaneous determinations at different places. Abbot has maintained that such variations have been established, and Clayton has attributed many variations of the weather to them. But the critical examination of the evidence for the existence of any variation of the solar constant large enough to be detected even by the most up-to-date methods, which occupies most of Miss Paranjpe's paper, appears to show that Abbot's supposed variations are illusory. If that is the case, none of the work based on them is valid. It does not follow, however, that still more refined methods of observation in the future may not lead to the detection of very small variations, such as are to be expected in view of the known changes of the sun's appearance.

Television

THE twenty-fifth Thomas Hawksley Lecture was delivered to the Institution of Mechanical Engineers on November 4 by Sir Noel Ashbridge, chief engineer to the British Broadcasting Corporation, the subject chosen being television. He began by pointing out that the scientific suggestions on which modern television is based were made at intervals extending over a period of more than fifty years. In 1873, a telegraph operator named May, almost accidentally, made the discovery that the value of selenium resistances varied according to the amount of light falling on them. This was confirmed by Willoughby Smith and Prof. W. G. Adams. The importance of this discovery lies in the fact that it provided for the first time a means whereby an electric current could be generated, the value of which varied in sympathy with the intensity of a beam of light.

The elementary telegraphy of pictures at rest presented no great difficulty, but television essentially includes the transmission and reproduction of moving objects, which introduces considerable complication. In the first place, the exploring of the subject, element by element, by a beam of light—usually called scanning—must be carried out rapidly, and the process repeated a sufficient number of times per second to give the illusion of uninterrupted movement when the picture is reproduced at the receiving end.

A very important step in the development of practical television took the form of a scientific forecast—one of the most remarkable ever made. In 1908, A. A. Campbell Swinton wrote a letter to NATURE describing a device which he considered a scientific possibility; this was the forerunner of the now famous 'Emitron' tube. It was not developed until twenty-five years later. This special form of electron tube constitutes the essential feature of the system now used for generating the picture currents at the London Television Station. In Great Britain it was developed by Electric and Musical Industries Limited. In the United States a tube based on the same principle has been produced by the Radio Corporation, and in other countries similar devices are being developed.

In Great Britain, between 1923 and 1928, J. L. Baird developed a complete system of television based on scanning with 30 lines and transmitting pictures at the rate of 12½ per second. He generally employed a mirror wheel—a development of the Nipkow disk principle—at the receiving end of his apparatus, in conjunction with selenium cells, the light beam being produced by an electric arc. Although an experimental service was operated by the B.B.C. for many months, it was never developed successfully on a service basis. It is now replaced by the 'high definition' system which operates at the London Television Station.

Many difficulties had to be overcome in establishing the high definition system. It is well known that it is necessary to use a wave-length of about eight metres. There was also the difficulty of establishing a definition standard which was likely to remain for a reasonable number of years without becoming obsolete. Thus it came about that in 1934 the Postmaster-General appointed a committee, under the chairmanship of Lord Selsdon, to study the whole problem. The Selsdon Committee made four recommendations: first, that high-definition television was sufficiently advanced to justify the establishment of a public broadcast service, and that the B.B.C. appeared to be the most suitable body to do this, in view of the possibility of its merging with sound broadcasting; secondly, that the two systems developed in Great Britain, namely, Baird Television, Ltd., and the Marconi–E.M.I. Television Co., Ltd., should each be given a practical trial; thirdly, that the definition standard should not be lower than 240 lines per picture and the number of picture repetitions not less than 25 per second; and lastly, that an advisory committee should be established for a period of about five years.

Thus it came about that a station was built to serve an area within a radius of about twenty-five miles from the centre of London, and equipped with two complete and different systems which were to be tried out under conditions which would allow of a comparative test of their respective merits. After some months of experience, the Committee decided to continue the service using one system only and one standard of definition. This was put into effect on February 5, 1937, when the 405-line, 50-interlaced frame standard was adopted. There is little doubt that should it become necessary in the future to increase greatly the degree of definition and therefore the range of frequencies to be transmitted, it will be necessary to use shorter wave-lengths. At the television station, the channels adopted were 6·67 metres for vision, and 7·23 metres for sound.

It has been frequently stated that propagation could not exist beyond the horizon. It is now known that the effective range is not limited to a visual path. Regular reception is known to be possible at fifty miles, while good pictures have been obtained at a distance of two hundred miles. In considering the site of the station, the main requirements were that it should be within a few miles of the centre of London, in order to give a strong service in the more densely populated areas, and that it should be on high ground relative to the London district in the broader sense. Taking everything into consideration, it was decided that the Alexandra Palace, in the north of London, would be the best site. There are two separate aerials, for vision and sound respectively, but both are carried on a single mast which is itself mounted on one of the brick towers forming part of the Alexandra Palace. The maximum height of the mast above ground level is about 300 feet—giving a total height of 600 feet above sea-level. The aerials themselves are therefore higher than the top of any building within a ten-mile radius of Charing Cross. This is important when considering the possibilities of propagation using wave-lengths of this type. When viewed from a distance, the mast and aerial relays are somewhat reminiscent of a lighthouse.

Public broadcasts of the Coronation, Armistice Service, the Derby, etc., have been very successful, and great improvements have been introduced by the new 'Super-Emitron', the output of which is

about ten times that of the ordinary emitron. As to the future, the Television Committee has announced that the present standards will remain in operation for at least three years. Any improvements during this time will not render existing receivers obsolete.

There is one aspect of television development which must be recorded with regret. At present, there seems no likelihood of international standardization with regard to definition and picture frequency standards. In the following countries the standards at the moment are as follows, although there is as yet no public service:

	Lines per picture	Pictures per sec.	Modulation
America ..	441	30	Negative
Germany ..	441	25	Positive
France ..	455	25	Positive

In the distant future, international television cables may become available. In this case the absence of a common standard in European countries will be a serious matter.

In spite of these early difficulties, there is no doubt that this new development of entertainment in the home will, in the course of time, reach the same degree of importance that sound broadcasting has done; in fact it may be readily anticipated that the two services will ultimately merge.

Localization in the Central Nervous System*

BY electrical stimulation of the brain, David Ferrier established the main facts relating to the localization of the motor centres in the cerebral cortex. These facts have been confirmed, on man as well as on animals, and have been of great practical as well as theoretical importance. But although they have been the basis for all attempts to analyse the cerebral organization, they reveal mainly its receiving and executive apparatus and show little of the intervening processes.

With the development of methods for recording the activity of the brain in terms of the electrical effects produced, the problems of cerebral localization can be approached from another aspect. It has been found that the cerebral cortex is naturally in a state of constant activity which may take the form of a rhythmic series of potential waves (for example, Berger's α rhythm) or of more complex and irregular oscillations. When the activity has been reduced by an anæsthetic, the arrival of an afferent message has a twofold effect. It produces a direct local excitation in the region in which it arrives and a more widespread increase in the persistent activity of this and neighbouring regions. The latter result may be considered a local or regional awakening, for it resembles the generalized increase in electrical activity which occurs in the brain when a sleeper is roused. In either case, a mutual reinforcement by cortex and thalamus is an important factor in raising and maintaining the level of the 'spontaneous' activity.

In certain cases, electrical stimulation of the brain has the same facilitating effect as an afferent message. The spread of activity can then be followed by making simultaneous records of the potential changes at different distances from the stimulated point, and it can be shown how a number of competing wave systems can come into being.

Electrical records have not yet revealed any features peculiar to the cerebral neurones. In other parts of the nervous system there are many examples of rhythmic activity favoured by the arrival of impulses, and in the cortex, as elsewhere, there are probably all grades of spontaneity, ranging from neurone systems which cannot help discharging periodically to those which need a specific stimulus for each reaction. Thus, the activity in a given region of the cerebrum will depend on the interactions of each, rhythmic and non-rhythmic systems. In normal conditions inhibition as well as facilitation will help to determine the local patterns of activity, but in records from the narcotized brain the excitatory factors are the more prominent.

* Abstract of the Ferrier Lecture of the Royal Society delivered by Prof. E. D. Adrian, F.R.S., on November 10.

International Cancer Research*

ACCOUNTS of the Second International Congress of Scientific and Social Campaign against Cancer which was held in Brussels in September 1936 have appeared previously in this journal (Nature, 138, 727; 1936. 139, 255; 1937). The second volume of publications of the Congress has now been published and contains accounts of some two hundred communications which were submitted to the Congress. The General Minutes of the Congress are to form volume 3.

The papers are divided into two main groups: the scientific, and the social campaigns against cancer; and these groups are again divided into sub-groups. Among the papers on the social campaign are some interesting statistics of cancer in Germany, Poland, Rumania, South Africa and the Dutch Indies. It is possible to refer to only a few of the papers in this review; emphasis will be laid on foreign scientific work, as British cancer research is often reviewed in these columns.

The first sub-group of communications on carcinogenic agents deals with the action of cancer-producing compounds, the nature of cancer viruses and the part played by hormones in the origin of cancer. Drs. J. Maisin and Y. Pourbaix describe how the production of cancer on the skin of mice by the active carcinogenic agent of tar, 3:4-benzpyrene, is inhibited by treating the animals with minute amounts

* IInd International Congress of Scientific and Social Campaign against Cancer. 2: Communications. Pp. xii+628. (Bruxelles: Marcel Hayez, 1937.)

of the oxidation products of ether. As yet the result has not been obtained with any pure compound.

Dr. N. Waterman, of Amsterdam, describes how carcinogenic agents inhibit the breakdown of cholesterol esters and possibly cause increased esterification of cholesterol in animals. The results indicate that agents which have a localized carcinogenic action may have a widespread effect in the animal. It is possible, but not certain, that general effects of this type may be an essential part of the carcinogenic action. Prof. F. Vlès and Dr. A. Ugo show that if mice are injected with the fluorescent carcinogenic agent, 3:4-benzpyrene, the hair becomes fluorescent and the spectrum resembles that of the original hydrocarbon. Drs. J. G. Chalmers and P. R. Peacock show that the same compound is excreted as a fluorescent derivative in the bile. It is also excreted in some form in the urine, and thus animals excrete carcinogenic compounds by three routes, in skin fat, bile and urine, but in most cases the compound produces tumours only at the site of application and not along the paths of excretion.

Dr. Albert Fischer, of Copenhagen, reports on some interesting transplantation experiments. Tissue from salivary glands, liver, ovaries and mammary glands of young mice was grafted at a different site in the same animal from which the tissue was taken. After 10–14 days, the graft was inserted in a fresh place in the mouse, and this was repeated several times. In some cases the regrafted tissue developed into malignant tumours, showing that normal tissue may become malignant either by selection or by change in the character of the cells.

Among a number of papers on the nature of tumour viruses is one by Dr. A. Claude, of New York, showing that the virus of the Rous sarcoma No. 1 is destroyed by incubation with crystalline trypsin. Crystalline carboxypolypeptidase had no action on the virus. These results indicate that the Rous sarcoma agent is a protein. Other experimenters have found that the agent is not completely deposited on centrifuging at 15,000 R.P.M. but is completely deposited at 50,000 R.P.M.

Several communications deal with inherited predisposition and resistance to cancer. The results of Dr. Maud Slye, of Chicago, on mice breeding, indicate that types of cancer segregate as unit characters, and the incidence of malignancy at different sites can be explained by laws of heredity. Dr. N. Dobrovolskaïa-Zavadskaïa introduced radon tubes into the groins of female mice which normally had a high incidence of mammary carcinoma. The total incidence of cancer was not changed by such treatment, but one third of the tumours in the radon-treated mice were sarcomata instead of the usual mammary carcinomata.

One section of the volume deals with cancer diagnosis. Prof. P. Lamarque, of Montpellier, shows photographs of tissues made by microradiography. These are taken by placing a thin section of tissue on specially fine-grained photographic film and exposing the tissue and film to feebly penetrating X-rays. Those parts of the tissue which contain heavy elements absorb the X-rays, and a photograph showing the distribution of heavy metals in the tissue is obtained. The results are similar to those obtained by microincineration, which shows the distribution of ash in tissues. Historadiography, however, has the advantage that the tissue is not treated so drastically as in incineration. It appears to the writer that a modification of this technique to determine the distribution of introduced radioactive elements such as radioactive phosphorus in tissues has possibilities.

The Second International Cancer Congress was well organized and the volume of "Reports" was published at the opening of the congress. The volume of communications contains many papers of value; it is unfortunate that they could not have been published immediately after the Congress. E. B.

Iron and Steel Works Developments

IN his presidential address to the Institution of Mechanical Engineers on October 21, Mr. David E. Roberts reviewed the changes which have taken place during the last fifty years in the basic industry of iron and steel making with which his experience has been primarily concerned. The twenty-five years preceding the Great War, when the world's annual output of steel increased from seven million to nearly seventy million tons, were marked by great activity in the development of improved processes of manufacture, and this period he regards as the one during which the greatest strides were made in the engineering side of the industry.

Sir Lowthian Bell, president of the Institution in 1884, established the ideal height for blast furnaces and, even to-day, few exceed 90 feet. In other respects, marked changes have been made. Hearths, from 11 ft. diameter, have been doubled in size while blowing pressure has increased from 5 to 25 pounds per square inch to ensure that the air will penetrate to the centre of the wider hearths. For blowing, Watt's beam engines with air cylinders 10-12 ft. in diameter are now replaced in Great Britain by turbines while, on the Continent, gas engines are largely used. Raw materials are much more carefully selected and graded and the result is easier working of the furnace, with a saving of fuel and an increased output. Blast furnace gas, now cleansed most thoroughly, is actually cleaner than the normal atmosphere. It is used for driving gas engines or, when mixed with the richer coke oven gas, for heating and smelting operations. In the Ruhr area, with its very numerous blast furnaces and coke ovens, the whole of the works are connected to a huge pipe grid and every cubic foot of gas generated is effectively used—there is no waste such as is sometimes seen in Great Britain. Steel manufacture has also developed greatly. The Bessemer converter has returned to favour for the production of commercial steel—on the Continent it has been practically the only method of making common steel. The open-hearth process is the British mainstay and these furnaces have increased from 20 to 100 tons capacity, while some tilting furnaces of 250 tons capacity are in use. Much mechanical equipment is installed in the melting shop to increase the speed of operation and to ease the labour and exertion involved in handling vast masses of molten metal.

In the rolling shops the simple type of reversing mill has given place to massive machines rapid in operation and provided with lifting tables and other manipulating devices. The absence of noise is remarkable when it is realized that at each reversal some 150 tons of machinery is brought to rest and re-started. An example of the adaptation of new materials to attain improved results is the use of fabric bearings to carry the heavy rolls. One of the most recent developments is the rolling of sheets by what is known as a 'strip mill'—composed of a continuous series of roll stands in tandem arrangement. Twenty of these huge mills are in operation in the United States and one is being installed in this country. The early attempts to roll sheets in a continuous mill were frustrated by the difficulty of ensuring that successive pairs of rolls were of exactly corresponding contour and consequent troubles with "ripples" ensued. The Ashland plant in 1922 demonstrated the correct principles and the American strip mills are now stated to have an annual capacity of 12 to 13 million tons. The graduation of the thickness of the sheet throughout such a mill is vitally important and automatic recording devices have to be employed so that variations can be shown on a much magnified scale.

Science News a Century Ago

Education in the Metropolis

The Statistical Society on November 19, 1838, held its first meeting of the session, the first communication being the third report of the Society's Committee appointed to inquire into the state of education in the Metropolis. This report contained a description of the schools in the parishes of St. George, St. James and St. Anne, Westminster. The area of these districts was 1,310 acres and the population, according to the census of 1831, 110,862. It was estimated that there were 21,502 children between the ages of five and fifteen years, and of these less than one third received instruction in a school. There were four kinds of private schools—dance schools, common day schools, middle and superior schools—besides charity and infant schools. The Committee had found the teaching imperfect, the surroundings often cheerless and there was a notable absence of a good supply of literature. Inquiries had been made at some five hundred houses and the members of the Committee had been met with courtesy.

Blasting by Electricity

At a meeting of the London Electrical Society on November 20, 1838, a paper was read by Martyn Roberts entitled "On the Use of Galvanism in Blasting Rocks". A report of the paper appeared in Sturgeon's *Annals of Electricity*, 3, p. 423. The author described experiments, which had been attended with perfect success, made on granite rocks in the neighbourhood of Penzance, Cornwall. His method was to bore a hole 2 ft. deep in the granite and place 3 in. of gunpowder in it. A wad of oakum was then driven in 9 in. from the top of the hole, leaving 12 in. of air between the wad and the powder. The upper part of the hole was filled with sand, "a convenience being allowed for placing a thin iron wire in connexion with the powder, which wire became red hot, and consequently exploded the charge, when connected with the voltaic battery".

Interior of the Earth

On November 22, 1838, W. Hopkins read a paper to the Royal Society entitled "On the State of the Interior of the Earth". The object of the paper was to inquire into the modes in which the 'refrigeration' of the earth may have taken place, on the hypothesis that its entire mass was originally in a fluid state; a hypothesis which was at first founded on astronomical considerations and was corroborated by the discoveries of modern geology exhibiting the apparent injection from below of large masses of unstratified rocks, through the fissures of sedimentary strata. In the course of his discussion, Hopkins said that the internal mass of the earth may consist of matter still in a state of fusion, or the earth may consist of an external shell and a solid central nucleus with an intermediate stratum of matter in a state of fusion, or the earth may be solid from surface to centre.

The author of this paper, William Hopkins, was born on February 2, 1793, and died on October 13, 1866. He began life as a farmer but at the age of twenty-nine years entered Peterhouse, Cambridge, and graduated as seventh Wrangler five years later. Settling at Cambridge as a tutor, he had among his pupils Stokes, Kelvin, Tait, Clerk Maxwell and Todhunter. It was through Sedgwick that he acquired a taste for geology. In 1850 he was awarded the Wollaston Medal for his application of mathematical physics to geology, and in the following year he served as president of the Geological Society. In 1853 he was president of the British Association. After his death the Cambridge Philosophical Society founded a prize in his honour.

University Events

Cambridge.—A. L. Percival, of Jesus College, and H. G. Rhoden, of St. John's College, have been appointed University demonstrators in engineering, and A. M. Barrett, of Pembroke College, has been appointed University demonstrator in pathology.

J. R. F. Jeffreys, of Downing College, has been elected to an Isaac Newton studentship.

The degree of Sc.D. has been conferred on F. Yates, of St. John's College.

T. P. Hughes, Rhondda research student, 1935–37, of Gonville and Caius College, has been elected into an unofficial Drosier fellowship for research in chemistry.

The following new appointments have been made in connexion with the Cambridge Philosophical Society: *Vice-President*, Prof. F. J. M. Stratton; *New Members of the Council*, Dr. E. C. Bullard, Dr. E. J. Maskell and Dr. F. C. Phillips.

Sheffield.—The following appointments have recently been made: Dr. G. K. T. Conn, assistant lecturer in physics; W. J. Lytle, honorary lecturer in surgical pathology; Dr. H. E. Harding, honorary lecturer in medical pathology; J. Hughes, honorary demonstrator in anatomy; F. G. West-Oram, at present junior research assistant, as assistant lecturer in glass technology.

Societies and Academies

Paris

Academy of Sciences (*C.R.*, **207**, 649–692, Oct. 17, 1838).

E. JOUGUET: Relationships between the problem of secular stability and that of critical speeds.

A. CHEVALIER: New African coffee trees as a principal source of coffees for French consumption. These indigenous coffees thrive in a relatively poor soil at altitudes of 0–600 m. in the regions of dense equatorial forests found in the French tropical colonies.

P.-A. DANGEARD: Mode of multiplication of flagella at each division in *Oxyrrhis marina*. The flagella of this peridinian divide longitudinally at each division.

L. ROY: Total action exerted due to magnetization in a system of isotropic bodies.

R. SALEM: A general test for uniform convergence of Fourier series.

L. BERGERON: The problem of the fall of a mass on an elastic rectilinear prism.

L. ESCANDE: Sluice-gates: experiments at the Valentine [hydro-electric] works [on the Garonne].

R. FORRER: Production of several magnetic products, starting from FeOOH. Non-magnetic FeOOH, when heated at different rates, yields four products, magnetically distinct, but all corresponding in composition to Fe_2O_3.

P. AUGER and R. MAZE: Study of cosmic ray showers at an altitude of 2,800 m. [at the Pic du Midi]. Observations were made with Geiger counters by the co-incidence method.

M. PRETTRE: Existence of two mechanisms for slow homogeneous oxidation of mixtures of hydrogen and carbon monoxide.

R. TRUFFAULT: Condensation of halogen derivatives of benzene with unsaturated hydrocarbons and with their halogen derivatives under the influence of concentrated sulphuric acid as catalyst.

J. ROUCH: Observations of the terrestrial electric field at sea.

M. PAGET and R. BERGER: Researches on human allantoinuria.

Y. RAOUL and P. MEUNIER: *Trans*-$\Delta^{5,6}$-dehydrodesoxo-androsterone. This compound has about 1/250 of the androgenic activity of testosterone and no œstrogenic activity.

J. COURTOIS: Synthesizing action of renal phosphatase.

M. POLONOVSKI and P. DESGREZ: Reducing properties of a tautomeric form of geneserine; an example of a chain reaction.

C. LEVADITI, R. FASQUELLE, R. BÉQUIGNON and L. REINIÉ: Influence of 'selectors' on the encephalogenic potential of Jenner vaccine.

E. BURNET: Positive inoculation of human leprosy into the golden hamster, *Cricetus auratus*.

Calcutta

National Institute of Sciences of India, September 26–27, 1938.

PUBLIC LECTURES:

S. S. BHATNAGAR: How chemistry can help Indian industries.

J. C. GHOSH: Poisonous chemicals in modern warfare: anti-gas defence measures.

M. N. SAHA: Geography of space.

SYMPOSIUM ON RECENT WORK ON THE SYNTHESIS OF NATURALLY OCCURRING SUBSTANCES:

J. N. RAY: Some recent developments in the study of the constitution of natural products.

P. C. MITTER: History of researches in organic chemistry in India (1896–1923).

P. C. GUHA and collaborators: Synthetic investigations on bicyclic terpenes.

D. CHAKRAVARTI: Synthesis of coumarins and chromones.

R. C. SHAH and collaborators: New synthetical methods in coumarin chemistry.

K. S. NARANG, J. N. RAY and B. S. ROY: The constitution of rottlerin.

K. VENKATARAMAN: Synthetical experiments in the flavone and isoflavone groups.

R. D. DESAI and S. ZAFARUDDIN AHMED: The colouring matter of the yellow flowers of *Thevetia Nerifolia* (Apocynaceæ).

R. C. SHAH, C. R. MEHTA and T. S. WHEELER: Attempted synthesis of oroxylin *A*, and the synthesis of wogonin.

T. S. WHEELER and collaborators: Synthesis of some naturally occurring flavones from chalkones.

Washington, D.C.

National Academy of Sciences (*Proc.*, **24**, 365–405, Sept. 15, 1938).

S. CHEVAIS, B. EPHRUSSI and A. G. STEINBERG: Facet number and the v^+ hormone in the bar eye of *Drosophila melanogaster*. Eye disks from Bar larvæ fed with extract of *Calliphora* larvæ, which increases number of facets in the eye, were implanted into vermilion hosts. Resulting eye pigmentation was the same as that of eyes from larvæ on standard diet.

B. P. KAUFMANN and RUTH C. BATE: An X-ray induced intercalary duplication in *Drosophila* involving union of sister chromatids.

S. WRIGHT: Distribution of gene frequencies in populations of polyploids. A theoretical discussion.

L. R. MAXWELL: Mechanism of delayed killing of maize seeds with X-radiation. Dry seeds are irradiated with 50,000–100,000 r.; germination occurs, but the seedling dies after reaching a height of 1–2 cm. (delayed killing). Statistical results of irradiating various zones of the seeds, indicate that there is no single 'sensitive' volume for a multicellular body.

H. JENNY and R. OVERSTREET: Contact effects between plant roots and soil colloids. Contact exchange involves a mutual transfer of ions, hence for every cation gained by the root (contact intake) an equivalent number of ions leaves the root surface and goes to the clay (contact depletion). Data for potassium in the latter process are discussed. In certain clay suspensions, roots containing radioactive potassium showed a net intake, but also parted with radioactive potassium to the clay. Intake of ions is not a uni-directional process; outgo is especially pronounced for roots in contact with colloidal systems.

S. LEFSCHETZ: Locally connected sets and retracts.

E. KASNER and J. DE CICCO: Conformal geometry of horn angles of second order.

C. R. DOERING and ALICE L. FORBES: A skeleton life table. A short method of computation based on 13 census groups or the 7 so-called biological groups gives a life-table claimed to be of sufficient accuracy for health officers.

Forthcoming Events

[Meetings marked with an asterisk are open to the public.]

Monday, November 21

Royal Geographical Society, at 5.30.—Miss E. J. Lindgren and A. Croft: "Summer and Winter Life in Lapland" (Film).

Thursday, November 24

Society of Chemical Industry and the Chemical Society (in the Leathersellers' Hall, St. Helen's Place, London, E.C.3), at 5.—Dr. H. Levinstein: Lecture to commemorate centenary of birth of Sir William Perkin.*

Chadwick Public Lecture (at the Royal Institute of British Architects), at 5.30.—W. W. Wakefield, M.P.: "Playing Fields and the National Fitness Movement" (Malcolm Morris Memorial Lecture).*

Friday, November 25

Geophysical Discussion (at the Royal Astronomical Society), at 4.30.—"The Electrical and Thermal Conductivities of the Earth", to be opened by A. T. Price.

Institution of Electrical engineers, at 6.—Discussion on "Non-Destructive Testing".

Institution of Chemical Engineers (at the Institution of Civil Engineers), at 6.30.—Prof. J. C. Philip: "Fog and Mist from the Physico-Chemical Standpoint" (Hinchley Memorial Lecture).

Royal Institution, at 9.—Sir James Jeans, F.R.S.: "The Problem of the Astronomical Universe."

Appointments Vacant

Applications are invited for the following appointments, on or before the dates mentioned:

Principal of the Newton-in-Makerfield Technical Institute and Junior Technical School—The Secretary, Newton-in-Makerfield Local Higher Education Sub-Committee, Town Hall, Earlestown, Lancashire (November 21).

Assistant Lecturer in Electrical Engineering in the Openshaw Technical School, Manchester—Director of Education, Education Offices, Deansgate, Manchester (November 26).

Lecturer (part-time) in Inorganic and Physical Chemistry in the Woolwich Polytechnic, London, S.E.18—The Secretary.

Reports and other Publications

(not included in the monthly Books Supplement)

Great Britain and Ireland

Department of Scientific and Industrial Research. Report of the Road Research Board with the Report of the Director of Road Research for the Year ended 31st March 1938. Pp. viii+191+18 plates. (London: H.M. Stationery Office.) 4s. net. [2710

London Shellac Research Bureau. Technical Paper No. 15: Shellac Esters—Esterification of Hydroxyl Groups of Lac with Acids. By Dr. R. Bhattacharya and Dr. B. S. Gidvani. Pp. 14. Free. Technical Paper No. 16: Fractionation of Lac. By Dr. R. Bhattacharya and G. D. Heath. Pp. 15. Free. (London: London Shellac Research Bureau.) [2710

Pioneer Health Centre, Ltd. Annual Report, 1937. Pp. 32+4 plates. (London: Pioneer Health Centre, Ltd.) [2710

Medical Research Council. Eighteenth Annual Report of the Industrial Health Research Board to 30th June 1938. Pp. iv+62. (London: H.M. Stationery Office.) 1s. net. [2810

ASLIB Book-List. Vol. 3, No. 4, June. Pp. 103–142. (London: Association of Special Libraries and Information Bureaux.) Free to Members; to non-Members, 10s. 6d. per annum. [111

Geological Survey and Museum. A Guide to the Geological Column exhibited in the Museum of Practical Geology. By Dr. R. L. Sherlock. Pp. ii+6. (London: H.M. Stationery Office.) 2d. net. [111

Technical Publications of the International Tin Research and Development Council. Series A, No. 78: A Study of the Mechanical Properties of Tin-Rich Antimony-Tin Alloys. By Prof. D. Hanson and Dr. W. T. Pell-Walpole. Pp. 24. Free. Series A, No. 79: The Nickel and Chromium Plating of Tinplate. By A. W. Hothersall and C. J. Leadbeater. Pp. 24+2 plates. Free. (London: International Tin Research and Development Council.) [111

Ministry of Agriculture and Fisheries. Final Report of the Departmental Committee on the Ordnance Survey. Pp. iv+39+11 maps. (London: H.M. Stationery Office.) 5s. net. [311

British Museum and British Museum (Natural History). Annual Report of the General Progress of the Museums for the Year 1937. Pp. 25. (London: H.M. Stationery Office.) 4d. net. [211

Institution of Structural Engineers. Report of the Committee on Air Raid Precautions. Pp. 48. (London: Institution of Structural Engineers.) 1s. [311

Colonial Office. Report and Proceedings of the Conference of Colonial Directors of Agriculture, held at the Colonial Office, July 1938. (Colonial No. 156.) Pp. 130. (London: H.M. Stationery Office.) 2s. net. [411

Department of Scientific and Industrial Research. Index to the Literature of Food Investigation. Vol. 10, No. 1, June. Compiled by Agnes Elisabeth Glennie, assisted by Gwen Davies and Catherine Robson. Pp. v+94. (London: H.M. Stationery Office.) 4s. 6d. net. [411

Other Countries

Transactions of the Academy of Science of St. Louis. Vol. 29, No. 6: Some Problems of the Middle Mississippi River Region during Pleistocene Time. By Percival Robertson. Pp. 165–240. (St. Louis, Mo.: Washington University.) 1 dollar. [2710

Tanganyika Territory: Department of Lands and Mines: Geological Division. Short Paper No. 18: The Geology of the North Ilunga Area. By Dr. A. C. Skerl and F. Oates. Pp. 38+2 plates. (Dar es Salaam: Government Printer.) 3s. [2710

Australasian Antarctic Expedition, 1911–14. Scientific Reports, Series C: Zoology and Botany. Vol. 2, Part 6: Crustacea Decapoda (in part). By Freda Bage. Pp. 13+1 plate. 3s. Vol. 2, Part 7: Cirripedia. By Freda Bage. Pp. 14+4 plates. 3s. 6d. Vol. 9, Part 5: Non-Calcareous Sponges. By Maurice Burton. Pp. 22. 3s. 6d. (Sydney: Government Printer.) [2810

U.S. Department of the Interior: Office of Education. Bulletin, 1938, No. 2: The School Custodian. By Dr. James Frederick Rogers. Pp. vi+44. (Washington, D.C.: Government Printing Office.) 10 cents. [2810

Tanganyika Territory: Department of Agriculture. Pamphlet No. 22: Fourth Annual Report of the Coffee Research and Experimental Station, Lyamungu, Moshi, 1937. Pp. 55. (Dar es Salaam: Government Printer.) 1s. 6d. [111

Journal of the Indian Institute of Science. Vol. 21A, Part 22: Supersonic Velocity in Gases and Vapours. Part 1: Aberrations of Supersonic Interferometers in Gases. By S. K. Kulkarni Jatkar. Pp. 245–272. 2 rupees. Vol. 21A, Part 23: Reactions of Chromates at High Temperatures. Part 7: Decomposition of Barium Chromate, and of Mixtures of Barium Chromate with Barium Carbonate. By V. T. Athavale and S. K. K. Jatkar. Pp. 273–284. 1 rupee. (Bangalore: Indian Institute of Science.) [111

Sveriges Geologiska Undersökning. Ser. Ca, No. 28: Stripa oddfälts geologi. Av Per Geijer. Pp. 43+3 plates. (Stockholm: P. A. Norstedt and Söner.) 6.00 kr. [111

New Zealand: Department of Lands and Survey. Annual Report on Scenery Preservation for the Year ended 31st March 1938. Pp. 16. (Wellington: Government Printer.) 6d. [111

New Zealand. Twelfth Annual Report of the Department of Scientific and Industrial Research. Pp. 128. (Wellington: Government Printer.) 2s. 3d. [111

Meddelande från Lunds Astronomiska Observatorium. Ser. 2, Nr. 94: Catalogue of Orbits for Visual Binaries. By Bengt Ekenberg. Pp. 34. Ser. 2, Nr. 95: La densité d'une nébuleuse obscure entourant le système solaire, calculée d'après les mouvements cométaires. Par Axel Corlin. Pp. 14. Ser. 2, Nr. 96 (Historical Notes and Papers, Nr. 13): Notes as to Cosmological Ideas in Al Quran. By Abdel Hamid Samaha. Pp. 6. Ser. 2, Nr. 97: Accidental and Systematic Errors of Modern Trigonometric Parallaxes. By Erik Holmberg. Pp. 68. Ser. 2, Nr. 98: Positions of 110 Stars mainly Eclipsing Binaries and Reference Stars of Nebulæ. By Erik Holmberg. Pp. 16. Ser. 2, Nr. 99: The Orientation of the Orbit Planes of Visual Binary Stars. By Folke Berglund. Pp. 12. Ser. 2, Nr. 102 (Historical Notes and Papers, Nr. 14): The Luni-Solar Calendar. By Lewis A.R. Wallace. Pp. 12. (Lund: Astronomiska Observatorium.) [111

Government of 'Iraq: Ministry of Defence: Meteorological Service. Annual Report of the Director, No. 2, Year ending 31st March 1938. Pp. 26. (Baghdad): Government Press.) [211

Scripta Academica Hierosolymitana: Simon Velikovsky Foundation. Scientific Report 1: Polycyclic Aromatic Hydrocarbons. By Ch. Weizmann and E. Bergmann. Pp. 42. (Tel Aviv: Scripta Academica Hierosolymitana.) [311

The Soaring Cycle. Pp. 58. (Washington, D.C.: The Soaring Flight Co.). 5 dollars. [411

Catalogues, etc.

Chemische Novitäten. Jahrgang 28, Heft 1, Juli. Pp. 72. (Leipzig: Gustav Fock, G.m.b.H.).

Catalogue of General Literature. (Catalogue No. 631.) Pp. 64. (London: Francis Edwards, Ltd.)

Aeronautik und Meteorologie in Auswahl: Bücher, Zeitschriften, Abhandlungen. (Antiquariatskatalog Nr. 724.) Pp. 32. (Leipzig: Gustav Fock, G.m.b.H.)

Movable, Focussing, Self-sustaining Fittings. Eighth edition. Pp. 22. (Hazel Grove, nr. Stockport: John Dugdill and Co., Ltd.)

Musik: Praktisch, Historisch, Theoretisch. Teil 3: McDowell–Roussier. (Antiquariats-Katalog Nr. 53.) Pp. 225–336. (Leipzig: Karl Max Poppe.)

Diffusion Pumps for the production of High Vacua. (Dif. 1.) Pp. 16. (London: W. Edwards and Co.)